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Oviphagous Embryos of the Sand Shark, *Carcharias taurus*

By Stewart Springer

CARCHARIAS TAURUS Rafinesque is the common sand shark of the north Atlantic coast of the United States, where the young and half-grown frequent shallow water. Along the southeastern coast of the United States the adults are common but irregular visitors. Coles (1915) reported of this species from North Carolina that several contained both eggs and 9-inch embryos. Whitley (1940) described egg capsules taken from a 9-foot *Carcharias arenarius* Ogilby, which died in the Sydney Aquarium. In addition to numerous egg capsules 3 by 1¼ inches, this shark was reported to have an unusually large mass of ovarian eggs each about 10 mm. in diameter. Springer (1943) obtained two large embryos and one small egg capsule from an unidentified Florida thresher shark, *Alopias*. The literature concerning the development of the young in the allied families Carchariidae and Alopiidae appears to be no more extensive than is contained in the accounts of these three anomalies.

Arthur F. McBride (personal communication) relates the following concerning a Florida specimen of *C. taurus* exhibited in the Marine Studios oceanarium:

> The large female—was collected on April 10, 1946, lived, ate not more than once or twice to our knowledge and died on March 9, 1947. This shark—total length 272 cm.—had two young, one in each oviduct. One, 105 cm. long, weighed 13½ pounds. The second, total length 103 cm., weighed 14 pounds. They were not enclosed in embryonic membranes.

On November 24, 1947, two *C. taurus* were brought to the dock at Salerno, Florida. One shark, 273 cm. in total length, had two female embryos 96 and 97 cm. long, one in each oviduct. The second adult, 239 cm. long, had one 83 cm. male embryo, and, while one of the oviducts was empty, its condition made it apparent that a second embryo had been present a short time before the examination. There were no shell membranes and no egg capsules were found. The skin of the embryos was rough with well developed denticles and the teeth were not covered by a sheath. The embryos were all oriented with the head toward the anterior end of the oviduct. They were robust with distended bellies and the stomach of each embryo was stretched to its apparent capacity solely with egg yolk material containing no shell or membrane fragments. The spiral valves of the embryos contained partially digested material. There was no visible yolk-sac attachment scar. The content of the stomach of one of the embryos was roughly estimated to be 28 ounces in volume. The oviducts of the adults contained no fluid, but if fluid had been present it would probably have been lost before delivery of the sharks to the dock. The oviducts were lined with villi but were not much thicker walled than oviducts characteristic of gravid galeid sharks. A single functional ovary (right) of the larger adult contained a few eggs, estimated at less than a hundred, and all about 10 mm. in diameter. The volume of the ovary was approximately 48 ounces.

On December 28, 1947, and again on January 22, 1948, gravid *C. taurus* were landed at Salerno. Only four of the December catch were examined in detail and recorded. These contained pups, one in each oviduct, and of approximately the same size as the November specimens. All of the pups had full stomachs containing only amorphous egg yolk material. Additional adult females were landed in December including several that had recently delivered young but no adult males were taken.

The January 22d landing included two adult females and four adult males. The smaller female contained two large embryos, one in each oviduct. The larger female carried no embryos but the oviducts were reduced in diameter at their anterior ends and still expanded posteriorly. The gravid female was preserved without opening the oviducts for examination. It was noted, however, that one of the embryos had reversed its position with its head pointed toward the posterior end of the oviduct. Also it appeared that this embryo was somewhat reduced in girth as compared to the other embryo. Among the December specimens reversal of direction may have occurred in one instance. One embryo was observed bent double, internally ruptured, and in rigor. An explanation which fits the conditions would be that the embryo was in the act of turning while the parent shark was on deck but at the critical moment another shark weighing several hundred pounds was dumped on top and forced the embryo to remain in a fixed position. Reversal of direction may be necessary before birth of an unsheathed pup because of its backward pointing denticles.

In July 1947, several adult female *C. taurus* were taken by the writer on chain set lines in 10 to 20 fathoms off Pass a Loutre, Louisiana. Conditions did not permit detailed examination of these specimens but it was noted that all were in the 8- to 11-foot length range and all had large masses of small ovarian eggs of uniform size. A few egg capsules similar to those described by Whitley for *C. arenarius* were picked up on deck. The oviducts were not opened or examined.

In order to get a specimen at a time when examination was feasible a special set was made and a gravid female, 10 feet 3 inches long, was brought aboard alive on July 27 from 10 fathoms a few miles off Chandeleur Island, Louisiana. In this shark the condition of the internal organs appeared to be essentially the same as in the other Louisiana specimens which had been only casually examined in the course of liver removal.

Only the right ovary was functional and it contained yellow eggs of remarkably uniform size. The average diameter of the ova was about 8 mm. None were appreciably larger, and, while there were many small spheres less than 1 mm. in diameter, those in the 1 to 6 mm. size range were rare. The ovary mass when removed almost exactly filled a 10-quart bucket. A calculation of the total number of mature ova present, based on a count of half a pint, was 24,000.

The right and left oviducts were similar. The portion of each oviduct leading from the shell gland was tube-like for about 10 inches and then expanded to a sac with a maximum diameter of about 10 inches. In the right oviduct there was one embryo 10¼ inches long and 71 egg capsules of which 10 were empty shells. In the left oviduct there was one embryo 10½ inches

long and 66 egg capsules, some of them empty shells. One of the embryos was a male and the other a female.

The egg capsules were thin walled but with a definite shape. They were softer and weaker than the egg capsules of *Ginglymostoma* or *Raja* but much stronger and heavier than the shell membranes characteristic of the galeid sharks. They were semi-transparent, yellowish, and uniform in size and shape. The length of one was 3¾ inches with one bulb-like end 1¼ inch in diameter and the other end flattened. Each of the capsules which remained undamaged contained a number of ova. There were from 16 to 23, and average of 19, in a series of 10 capsules opened. Lack of facilities for observation precluded any positive determination of fertility of ova in the egg capsules.

The embryos were pinkish white with semi-transparent skin and undeveloped denticles. The gills did not project from the gill slits. A large yolk attachment tubercle was present. Examination of the embryos began in a startling way. When I first put my hand through a slit in the oviduct I received the impression that I had been bitten. What I had encountered was an exceedingly active embryo which dashed about open mouthed inside the oviduct. The teeth were not strong enough to penetrate my skin but were sharp and hard enough to produce a pricking sensation. There was no sheath covering the teeth.

The bellies of both embryos appeared to be greatly distended and one was dissected at once. The stomach contained a large amount of egg yolk material which accounted for the swollen appearance. Two ova were found intact in the stomach but no egg capsules or membrane fragments were present. The embryo's spiral valve contained a substantial quantity of green and brown material indicating that the entire digestive tract was functioning in the utilization of the eggs as food. In the other embryo, examined on the following day, the condition of the digestive tract was the same except that the stomach contained amorphous yolk material without an intact egg.

This second embryo was left in the fluid in the oviduct and maintained a restless but irregular activity for nearly two hours before it died. The embryo kept its mouth open and exhibited well co-ordinated swimming movements seemingly directed toward the maintenance of a position with its dorsal side uppermost. Movements which were primarily respiratory were not observed. This embryo, with a few ovarian eggs and some egg capsules, was preserved and is USNM No. 143423.

If the short series of nine gravid female *C. taurus* is representative, it can be said that only one embryo completes its development at one time in one oviduct. Since there is no shell membrane to sheathe the late embryo and since it has a rough skin, the question arises as to whether two embryos could occupy the same oviduct without serious injury to the other. If only two young are produced, and if the sexes occur in approximately equal numbers, survival of the species must depend on the possibility for repetition of the reproductive cycle. In some of the other large sharks the question of whether females are capable of producing a series of litters has not been answered.

A review of the modes of development of young in representative species

of several elasmobranch families given by Gudger (1940) emphasizes the diverse character of their specialization in mechanisms for nourishing large embryos. No condition has been reported, however, which is similar to that found in *C. taurus*. The unconfirmed report (Springer, 1943) that an unidentified thresher shark produced a small egg capsule and large embryos suggests that similarities exist in the embryonic development patterns of the Carchariidae and Alopiidae. In this connection it is noteworthy that large embryos of *Alopias vulpinus* from Woods Hole are reported to show evidence of yolk sac attachment but near full term *C. taurus* embryos show no trace of scars. The indications furnished by scars or incompletely healed spots of attachment of a yolk sac or pseudoplacenta are useful for the determination of age in museum specimens but for *C. taurus* the criterion would require special interpretation.

The ability of the species (*C. taurus*) to produce many young appears to have been sacrificed in order to produce a few of large size. It is possible that the present condition may have been achieved in two major steps beyond the primitive condition of development of each naked egg. At least there are two development stages which broadly parallel one another, the end of the first phase marked presumably by hatching of a single active embryo from an egg capsule which had originally contained several ova.

The second step in the development of the reproductive pattern is the assumption of a free mode of life in the oviduct. This phase is characterized by an increasing demand for food as growth progresses, with ingestion of the content of large numbers of egg capsules and decreasing activity due to restrictions of space.

Speculation on the size differences of the ovaries of adults at different seasons and the volume of yolk material in the stomachs of the embryos leads to the opinion that the rate of digestion by the embryo may be slow. Unfortunately, speculation also leads to the question of whether digestion is a proper term for the method of utilization of nourishment described here and to innumerable other questions for which the available material presents no answer.

It is evident that this species sends forth into the world not only large, well developed, and even experienced young but may send them forth with a full stomach. Also it is possible that birth proceeds as a direct result of a hunger drive on the part of the embryo which causes it to reverse its direction when egg production falls below a satisfactory level. These are not necessarily conflicting inferences considering the normally overstuffed condition of the stomachs of the species at all ages.

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SHARK INDUSTRIES DIVISION OF THE BORDEN COMPANY, STUART, FLORIDA.

Notes on Fishes of the Genus *Scorpaena* from the South Atlantic and Gulf Coasts of the United States, with Descriptions of Two New Species

By GORDON GUNTER

THROUGH the kindness of Mr. W. W. Anderson, the writer had the opportunity of examining the collections of scorpaenids of the Shrimp Investigations, U. S. Fish and Wildlife Service, comprising 38 specimens. They were collected in shrimp trawls and try-nets along the South Atlantic and Gulf Coasts during 1938, 1939 and 1940. I have examined 6 other specimens from Florida, loaned by the Museum of Zoology, University of Michigan; 16 from Florida and one from Bahia, Brazil, loaned by the U. S. National Museum; 2 from Florida, collected by Br. J. C. Galloway, of Port Allegany, Pennsylvania; and 14 from off Galveston, Texas, donated by Mr. J. L. Baughman, of the Game, Fish and Oyster Commission. Four specimens caught by shrimp fishermen off Port Aransas, Texas, were studied. The following abbreviations are used: UMMZ = University of Michigan Museum of Zoology; USNM = U. S. National Museum.

Scorpaena agassizii Goode and Bean

A specimen 121 mm. in standard length was taken by the Shrimp Investigations at Pelican Station 143-4, March 5, 1939, off the northwest Florida coast, Lat. 29° 44.5′ N, Long. 86° 34.5′ W, depth 65 fathoms.

Scorpaena brasiliensis Cuvier and Valenciennes

Three specimens from Boca Ciega Bay, Florida, near Pass a Grille, collected by W. G. Fargo on April 14, 1936, UMMZ No. 110700, were examined. The standard lengths ranged from 43 to 70 mm. The median rays of the pectoral fin of the smallest specimen were not branched, and therefore this character does not separate the smallest members of this species of *Scorpaena* from the genus *Pontinus*. The number of branched pectoral rays in this species increases with size, as in *S. plumieri* Bloch (Gunter, 1941). The posterior supraocular tab is quite long in all 3 specimens, reaching to or almost to the first dorsal spine. The smaller specimens are deeper bodied, with a distinct hump anteriorly. The dorsal outline from this point

forward, including the head, therefore forms a greater angle with the horizontal than it does in larger specimens. Seventeen fish, from 41 to 98 mm. in standard length, had depths ranging from 34.8 to 43.9 per cent of the standard length, averaging 38.5 per cent. Sixteen fish, ranging from 103 to 222 mm. in standard length, had depths ranging from 31.8 to 37.4 per cent of the standard length and averaging 34.9 per cent.

Two specimens, 67 and 73 mm. in standard length, collected at Pine Key, Florida, by F. M. Gaige, in March, 1925, UMMZ No. 65913, were typical in all respects.

A single specimen from the University of Michigan collection, labeled Orig. No. 398, presumably from Florida, is 107 mm. long. It possesses no supraocular tabs and has a much larger eye than any other member of this species seen. The orbit is 3.3 in head. The ocular tabs in the Scorpaenidae are quite variable, as the writer (Gunter, *op. cit.*) has pointed out before, and this seems to hold true for all species except *Scorpaena grandicornis* Cuvier and Valenciennes. That species always has a long, thick, fleshy tab. The long-tabbed, smaller members of *S. brasiliensis* may be separated from *S. grandicornis* by their flat and leaf-like tabs. However, the deeper occipital pit and absence of postfrontal spines in *S. grandicornis* are better distinguishing characters.

Two specimens, 45 and 61 mm. in standard length, collected in Lemon Bay, Florida, in "grassy water" 3 feet deep, by J. C. Galloway on February 15, 1939, are typical. The larger fish has a very long supraocular tab. The head is 27 mm. long and the tab is 14 mm. long, reaching beyond the origin of the dorsal fin.

A small specimen loaned by the Chicago Natural History Museum, Catalogue No. 37681, was collected at Englewood, Florida, in Lemon Bay, on February 15, 1939. It is 51 mm. in standard length and agrees with other small specimens examined in being deeper-bodied than larger ones and in having the rays of the pectoral unbranched.

Seventeen specimens from Florida, mostly from Dry Tortugas and the Keys, loaned by the U. S. National Museum, were typical in all respects. The size range is from 52 to 184 mm. in standard length. The base color is a light brown. Many specimens show irregular spots and flecks of enamel white on the body and fins. A specimen 104 mm. long from off Bahia, Brazil, collected by the "Albatross" in 1887, corresponds in color and is typical, except that there are no supraocular tabs and there is a general absence of skin flaps and tabs over the head and body. The writer (Gunter, *op. cit.*) previously noted the same "bald" appearance in a specimen of *S. plumieri* from Brazil.

Two specimens collected in Biscayne Bay, Florida, by the Shrimp Investigations on September 5, 1938, are 94 and 106 mm. long. In the larger specimen the supraocular tab reaches past the origin of the dorsal, while in the other it is much shorter and reaches only beyond the nuchal spine. The fish are not as humped or deep-bodied as the smaller specimens. The color is dark grayish-brown above, becoming lighter below, with several irregular dark blotches above the lateral line and dark brown specks on the axil, sides of the belly and posterior part of the trunk. The fins are heavily barred, with only small, irregular light areas.

Two specimens taken by shrimp trawlers off Galveston, Texas, on August 11, 1940, donated by Mr. J. L. Baughman, are the first reported from the western Gulf of Mexico. They are 90 and 106 mm. long. The color pattern is very similar to that of the two specimens from Biscayne Bay, Florida. The base color is gray instead of brown, and the ventral regions have a faint underlying pink. The specks on the axil and belly are smaller and not so diffuse. The supraocular tabs are short, not equaling the orbit in length. The head spines are more blade-like or knife-edged than in the other members of this species seen.

In addition to the above specimens, the Shrimp Investigations collection contains 9 fish from the Atlantic Coast, from South Carolina to Florida, which I at first thought were *Scorpaena colesi* Nichols, described on the basis of one specimen from North Carolina (Nichols, 1914). These fish are much like *S. colesi* in color and some of them are quite large. However, Mr. Nichols was kind enough to compare 3 of the specimens with the type of *S. colesi* at the American Museum of Natural History and he says that although they "approach from *brasiliensis* to the type of *colesi*," they confirm the opinion that *S. colesi* is recognizably different.

The standard lengths and station records are listed below.

1, 120 mm., New Smyrna Bar, Florida, June 2, 1935.
1, 219 mm., Pelican Station 177-4, Lat. 30° 45.0′ N. Long. 80° 34.0′ W., off the south Georgia coast, Jan. 26, 1940, depth 19 fathoms.
1, 162 mm., Pelican Station 182-26, Lat. 32° 49.5′ N. Long. 78° 43.0′ W., off Charleston, South Carolina, Feb. 2, 1940, depth 18 fathoms.
1, 222 mm., Pelican Station 181-13, Lat. 32° 03.0′ N. Long. 70° 49.5′ W., off Savannah, Georgia, Feb. 3, 1940, depth 14 fathoms.
1, 162 mm., Pelican Station 182-10, Lat. 32° 26.0′ N. Long. 79° 13.0′ W., off St. Helena Sound, South Carolina, Feb. 4, 1940, depth 22 fathoms.
1, 137 mm., Pelican Station 195-7, Lat. 31° 50.5′ N. Long, 79°26.5′ W., off the mouth of the Ogeechee River, Georgia, March 13, 1940, depth 45 fathoms.
1, 40 mm., Pelican Station 200-1, Lat. 30° 44.0′ N. Long. 81° 22.0′ W., off the South Georgia coast, March 27, 1940, depth 6 fathoms.
1, 41 mm., Pelican Station 200-3, Lat. 30° 39.5′ N., Long. 81° 13.5′ W., S.E. of Fernandina, Florida, depth 9 fathoms.
1, 62 mm., Pelican Station 207-1, Lat. 28° 21.5′ N., Long. 80° 33.5′ W., off Cape Canaveral, Florida, depth 19 fathoms.

The larger specimens are among the largest ever reported. All are pale to dark straw color, with the exception of two of the small ones listed, and the caudal and pectoral tips are dark. Specks are present on axil and sides. *S. colesi* differs in having these specks also on the upper inside of the pectoral, near the base. The 2 specimens of *S. brasiliensis* in the Shrimp Investigations collection, listed above, are by contrast very heavily colored and dark. These fish vary in their degree of "shagginess." Some have many flaps and tabs over the head and body, with prolonged flaps over most of the large scales, which stand out when immersed in liquid.

Scorpaena calcarata Goode and Bean

The Shrimp Investigations collection contains 25 specimens ranging from 31 to 101 mm. in length. Three fish are labeled "Miscellaneous, Georgia." The date and precise locations at which they were caught are not known. One specimen was taken off the Cape Canaveral, Florida, pier on January

13, 1938. The remaining 21 specimens were taken at the following "Pelican" stations:

Station	Location Lat.	Long.	Coast	Depth in fathoms	Date
5	29°28.0′N	88°40.0′W	Louisiana	19	Jan. 29, 1938
80–7	28°40.0′N	90°51.5′W	"	8	Jul. 10, "
84–1	28°22.5′N	91°44.5′W	"	32	" 12, "
87–4	28°57.0′N	89°43.0′W	"	27	Nov. 10, "
98–7	28°47.5′N	92°10.5′W	"	17	Jan. 14, 1939
105–2	28°47.5′N	94°39.0′W	Texas	11	" 21, "
108–12	27°42.5′N	96°21.5′W	"	35	" 23, "
112–5	27°12.5′N	96°54.0′W	"	26	" 30, "
113–9	27°05.0′N	96°49.5′W	"	35	" 31, "
170–3	28°35.3′N	80°11.0′W	Florida	20	" 18, 1940
182–21	32°52.5′N	79°09.0′W	South Carolina	11	" 11, "
182–22	32°52.0′N	79°04.0′W	" "	11	" 12, "
187–1	34°16.5′N	76°24.0′W	North Carolina	17	Feb. 27, "
198–2	30°58.5′N	80°10.5′W	Georgia	22	Mar. 15, "
198–4	30°54.5′N	80°28.5′W	"	20	" 16, "
198–5	30°52.0′N	80°37.5′W	"	17	" " "
198–7	30°48.0′N	80°55.5′W	"	12	" " "
204–2	29°03.0′N	80°12.5′W	Florida	30	" 29, "
204–7	28°32.0′N	80°19.0′W	"	14	" " "

Thirteen specimens of this species, taken in a shrimp trawl off Galveston, Texas, on August 11, 1940, were given to me by Mr. J. L. Baughman. They vary from 62 to 84 mm. in length and are typical in all respects. The exact depth of the water was not given. The type of *Scorpaena russula atlantica* Nichols and Breder (1924), which Longley and Hildebrand (1941) have synonymized with this species, was taken off Galveston. Mr. Baughman said his specimens were rosy-red when caught and Longley (*op. cit.*) noted the same thing at Tortugas, saying that on fish in aquaria the red is largely replaced by brown. Mr. Baughman's fish are now faintly pink ventrally and brown or brownish above and on the fins. The diffuse brown spot below the lateral line or with the line running through it, under the spinous dorsal, which Longley (*op. cit.*) previously noticed, seems to be present in all specimens.

The information now at hand indicates that *Scorpaena calcarata* is the commonest scorpaenid of the South Atlantic and Gulf, ranging in the offshore waters from North Carolina to Texas, at depths from about 8 to 35 fathoms. *S. brasiliensis* seems to be the most common species in shallow water, although it ranges into water up to 45 fathoms.

Scorpaena ginsburgi Gunter

One specimen, 152 mm. long, was taken in a shrimp trawl in the lower end of Aransas Bay, Texas, on November 20, 1945. The color pattern is the same as was described for the holotype (Gunter, 1942: 106-108), but the color is darker, being almost black in the darker areas. This specimen, taken within a few miles of where the holotype was caught, may be called a subtopotype.

One specimen, 197 mm. long, was taken at the type locality of this species

on November 30, 1945. It has the same dark coloration as the above specimen. A third specimen of the same length, taken at the type locality on December 3, 1945, and mounted by a taxidermist, also had the same dark coloring.

One specimen, a topotype 94 mm. long, was brought in alive on January 20, 1946, and was kept in a bucket for several hours. It rested and moved about on the outstretched pelvic and pectoral fins much as the sea robins (*Prionotus*) do. This fish was accustomed to lying perfectly still for long periods of time, but when disturbed it moved with explosive suddenness. Longley (Longley and Hildebrand, 1941) noted that *Scorpaena plumieri* had the same habits.

This species is brilliantly colored when alive, but preserved specimens give no indication of the color and very little of the pattern. The pelvic fins are brilliant crimson. The pectoral fin is bright yellow in the central inside part, shading to brown and black on the margins. The axil is spotted with enamel white dots on a black background. The head and shoulder region is dark grayish-brown with underlying mottling shades of purplish-red. This dark region extends out onto the spinous dorsal and breaks off sharply into a light arenaceous color from about the beginning of the soft dorsal back to the anal. This region has some splotches of pure enamel white, extending onto the skin tabs. There is another dark region extending from the anal to the tail and the colored part of the dorsal is a mottled purplish-red. In life this species is extremely shaggy, with short flaps and tabs which do not stand out well after preservation.

Scorpaena ***similis,*** new species

One specimen, the holotype, USNM No. 124332, was taken at Pelican Station 74-3 (Lat. 29° 4.0′ N., Long. 88° 44.5′ W.) in 60 fathoms of water. This station is a few miles east of the mouth of the Mississippi River.

DESCRIPTION.—Dorsal XII, 9 (last split); anal III, 5 (last split); pectoral 19, first unbranched, next seven branched, lower 11 unbranched; pelvics I, 5, last ray adherent to belly for half of its length. Scale count 6-50-15. Lateral line with twenty-four tubules. Scales large, cycloid, and deciduous, with margins directed slightly upward. Gill-rakers 9 on the first lower bar. Tongue adherent, with no free margin anteriorly. Villiform teeth present on mandibles, premaxillaries, vomer, palatines and upper and lower pharyngeals.

Measurements in mm.—Total length 172, standard length 131; depth 52; width 35; head 66; snout 20; maxillary 33; orbit 18; interorbital 9; longest dorsal spine (fourth) 30; longest soft dorsal (fifth) 29; longest and strongest anal spine (second) 34; longest soft anal (second) 35; middle caudal ray 39; pelvic spine 22; longest soft pelvic (second) 34.

Body proportions in standard length.—Depth 2.52; head 1.98; snout 6.55; maxillary 3.97; orbit 7.28; interorbital 14.56. Percentage of standard length: depth 39.7; head 50.4; snout 16.6; maxillary 25.4; orbit 13.8.

Following the terminology of Schultz (1943: 168), the following spines are present on the head: nasals, pre-, supra- and post-oculars, post-frontals, parietals, nuchals, bifid tympanics, pterotics, 2 posttemporals on each side, extremely minute sphenotic and postorbitals, and a high-placed humeral.

There are 2 opercular spines at upper angle of operculum and a short blunt one on lower part; 5 preopercular spines, the upper one largest, with a supplementary spine at its base; suborbital with 4 spines, preorbital with 3, the first 2 antrorse. Coronal spines absent. A shallow, square pit, bordered by a bony ridge anteriorly and on the sides, is present in the occipital region. It is wider than long. The interorbital is a wide, deep, concave area with 2 faint coronal ridges near the center. The head and mouth are large, with the large eyes much in profile. There are a few small skin flaps on the body and eight on the lateral line. There are flaps on the chief preopercular spines, on the preorbitals, overhanging the inner end of the maxillaries, and on the anterior nares. There are short flaps at the preocular spine and a pair of long ones at the supraoculars. The latter are about 14 mm. long. There are several leaf-like flaps on the upper part of the eye. One of them is quite long, measuring 9 in length. Plate I is a drawing of the type.

The color of this fish is pale, with some diffuse darker coloring on the upper body and on the head and dorsal fins. There is no clear-cut pattern. There is a light bar on the mid-tail and several light spots posteriorly. There are light specks on the anal. The axil is pale, but there are several dark spots arranged in bars on the inner side of the pectorals. There are also diffuse, larger, dark spots on the upper part of the outer side of the pectorals.

The fins are long. The anal reaches to the tail, the pectorals reach slightly beyond the anal, and the pelvics reach almost to the anal.

Comparisons and Relationships.—This fish is similar to *S. dispar* Hildebrand in having 3 spines on the preorbital. In the large fins and eyes, it resembles *S. agassiz,* although these structures are not so large as in that species. It approaches *S. plumieri* in the large head and wide mouth, and is similar to *S. colesi* in the pale coloring and shallow occipital pit. Due to the points of similarity to other species, it is named *similis.* It differs from all of these species, except *plumieri,* in having the second anal spine the largest and longest, and differs from all except *dispar,* and the new species described below, in having 3 spines on the preorbital. *S. similis* has a much broader head and interorbital than *S. brasiliensis.* It has larger eyes, a wider interorbital, and longer fins than *S. plumieri,* and it differs also in having no suborbital pit and a shallower occipital pit. The type specimen differs from all the other species in having the large tabs on the cornea, but this may not be a constant characteristic.

Scorpaena ***microlepis,*** new species

This species is represented only by the holotype, a specimen 90 mm. long, collected off Englewood, Florida, by workers of the Bass Biological Laboratory on January 7, 1936; UMMZ No. 110161.

Description.—Dorsal XII, 9; anal II, 5 (second spine strongest and slightly longest); pelvics I, 5; pectorals 18, the last ray unbranched, the next 6 branched and the lower 11 unbranched. Scale count about 10-70-25. Scales cycloid. Lateral line with 24 tubules. Vomerine, palatine, pharyngeal, premaxillary and mandibular teeth present. Nine short gill-rakers on the first lower bar.

Measurements in millimeters.—Total length 119; standard length 90;

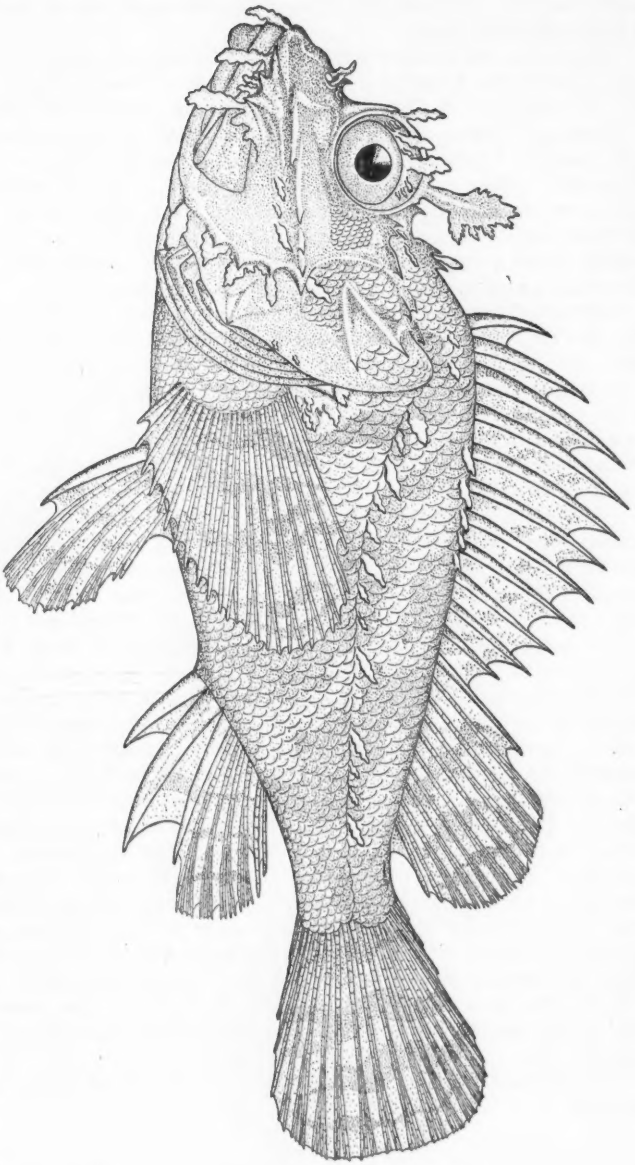

PLATE I

Scorpaena similis, n. sp. Holotype, USNM No. 124322, 131 mm. in standard length, from a few miles east of the mouth of the Mississippi River.

maxillary 17; orbit 10; interorbital 5.5; longest (fourth) dorsal spine 19; longest (second) anal spine 19; pectoral 28 from upper base to tip; pelvic 26 from upper base to tip.

Proportions.—In standard length: depth 3.0; head 2.4; snout 4.7; maxillary 5.3; orbit 9.0; interorbital 16.4. Percentage of standard length: depth 33.3; head 42.2; snout 21.1; maxillary 18.9; orbit 11.1; interorbital 6.1.

Nasal, pre-, supra- and post-ocular, postfrontal, parietal, nuchal, tympanic, pterotic, 2 posttemporals, humeral, and sphenotic spines are present. There are 5 spines on the opercular margin, the upper one longest and with a low auxiliary spine at its base. There are 2 minute spines on the suborbital keel. There are 3 spines on the preorbital, the first 2 antrorse. Scapular spines are present. There are 2 well-marked coronal ridges in the interorbital space, running to the border of the occipital pit.

Comparisons and Relationships.—In shape and superficial appearance this fish is very similar to *S. brasiliensis,* except that it has a broader head. The maxillary almost reaches a vertical with the posterior margin of the eye. A small symphyseal knob is present on the lower jaw. The pelvic fins reach half way between the anus and the anal fin. The pectoral fins reach a point almost even with the origin of the anal fin.

The color in formalin is a dark nut brown, fading a little ventrally, with some irregular splotches above the lateral line. There are 3 irregular brown bars on the soft dorsal and 3 on the anal. The membrane of the spinous dorsal is largely brown. The pectoral is mottled and barred with brown except for a lighter distal portion. The posterior two-thirds of the tail is marked in the same way, preceded by a small colorless area and a dark, narrow bar at the origin. There are no specks on the pectoral axil.

This species seems to be closest to *S. brasiliensis* and *S. dispar* Longley and Hildebrand. Like *dispar* and unlike *brasiliensis* there are 3 spines on the preorbital, the first two antrorse. It differs from *dispar* in having only 2 very low spines on the suborbital keel, in advance of the terminal ones, instead of 4 large ones. Dr. Hildebrand generously assisted the writer by comparing this fish with the type of *S. dispar.* He pointed out in a tabulated series of measurements that the interorbital is broader and that all fins are larger, the spines and rays being longer, than in *dispar.* Similarly the interorbital is broader than that of *S. brasiliensis* and the configuration of the occipital pit differs in the two species. In *microlepis,* the pit is much shallower and is broader anteriorly than in *S. brasiliensis,* and the postfrontal spines are much wider apart than are the parietal (post-occipital) spines, which lie just behind the occipital pit. In addition there is a V-shaped ridge projecting backward from the interorbital space, forming the anterior border of the occipital pit. This fish differs from all members of the genus *Scorpaena* in the small scales; hence the name, *microlepis.* Plate II is a drawing of the type.

I am indebted to Mrs. Thelma E. Ratisseau for both drawings used in this paper.

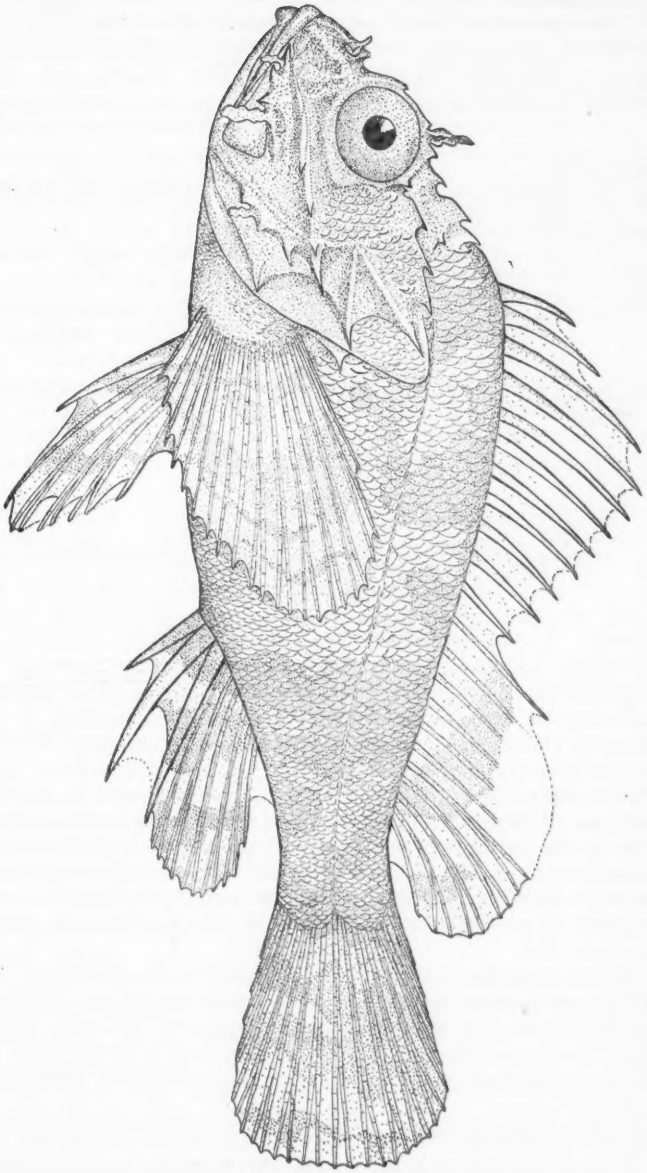

PLATE II

Scorpaena microlepis, n. sp. Holotype, UMMZ No. 110161. 90 mm. in standard length, from off Englewood, Florida.

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A Natural Hybrid Catfish, *Schilbeodes miurus* x *Schilbeodes mollis*

By MILTON B. TRAUTMAN[1]

ON JUNE 27, 1929, Mr. Edward L. Wickliff collected a small catfish along the weedy, muddy south shore of western Lake Erie, in Portage Township, Ottawa County, Ohio, 2 miles east of the village of Port Clinton and the same distance east of the mouth of the Portage River. Shortly after its capture Dr. Carl L. Hubbs and I were requested to identify the specimen. This we did, identifying it as *Schilbeodes nocturnus* (Jordan and Gilbert), the freckled madtom. As such, it was the first record for the species from the waters of the Great Lakes. This record was published by Osborn, Wickliff, and Trautman (1930: 170), and later by Hubbs and Lagler (1941: 67 and 1947: 73), Gerking (1945: 75), and Trautman (1940: 22 and 1946: 30).

Since our original examination of the specimen Dr. Hubbs and I have been at various times uncertain as to the correctness of our identification, and at intervals one or both of us have re-examined it. In certain characters, such as the deeper body, larger eye, longer pectoral and dorsal spines, it did not agree with the *S. nocturnus* that had been collected in Oklahoma and Missouri.

While completing recently plates of the 170 species of fishes for my

1 I wish to acknowledge the valuable suggestions given me by Drs. Carl L. Hubbs, Reeve M. Bailey, and William A. Gosline. I am particularly indebted to Mr. William R. Taylor who spent several days selecting, from the MZUM collections, some of the specimens that were used in this study; also to the Ohio State Museum for the loan of the hybrid, and the Museum of Zoology of the University of Michigan (MZUM) for loan of specimens of *Schilbeodes miurus*, *S. mollis*, and *S. nocturnus*.

forthcoming illustrated key of Ohio fishes, it became necessary to measure and critically re-examine the specimen before drawing it, and much to my surprise, I discovered that it was a hybrid between *Schilbeodes miurus* (Jordan), the brindled madtom, and *Schilbeodes mollis* (Hermann),[2] the tadpole madtom. It may appear odd that we did not sooner recognize the hybrid nature of the specimen unless it is realized that (1) we knew of no reference in literature to hybridization in the family Ameiuridae (although we were acquainted with hybridization in other groups and suspected that catfish hybrids existed), (2) the color pattern of *miurus*, one of the parents, should have been plainly discernible in the hybrid but was not because the fish had been killed in a strong formalin solution which greatly contracted the chromatophores, thereby masking the pattern and bleaching the specimen, (3) sexual and age dimorphism are extreme in the Ameiuridae, which makes identification of some individuals difficult, and (4) certain characters, such as length of nasal barbel, and particularly the included lower jaw, are very similar to those of *nocturnus*.

In this paper the hybrid, and 3 series of 10 individuals each of *miurus*, *mollis*, and *nocturnus*, were used for measurements and counts in Table I. The specimens are from the following collections and localities:

The hybrid is from the Ohio State Museum fish collections, and is No. F 300.

All 10 specimens of *miurus* are from streams flowing into Lake Erie in northwestern Ohio and southeastern Michigan; 2, Nos. 1061 and 1222, are in the F. T. Stone Laboratory collections; the remainder, Nos. 86024 (2), 106880 (3), 108064 (3), are in the MZUM collections.

All 10 specimens of *mollis* are from streams flowing into Lake Erie in northern Ohio; 8, Nos. 1967 (2), 3388 (1), 3476 (3), 3454 (1), 4565 (1), are in the Stone Laboratory collections; Nos. 118329 (1) and 118499 (1) are in the MZUM collections.

All 10 specimens of *nocturnus* are from tributary streams of the Mississippi River system in Oklahoma and Missouri, and are in the MZUM collections, Nos. 12730 (2), 137903 (2), 142203 (1), 142260 (1), and 153151 (3).

All specimens of *miurus* and *mollis* are females, as is the hybrid. Only 4 *nocturnus* in the standard length range of 39 to 52 mm. could be sexed definitely as females, the remaining 6 were not sufficiently developed to sex or were immature males. Sexual dimorphism was negligible in *nocturnus* under 52 mm. in standard length, and there were no significant differences between the averages of the 4 females and averages of the immature, unsexed specimens and males.

The hybrid index here used is the same as that introduced by Hubbs and Kuronuma (1942: 291). In a later paper Hubbs, Hubbs, and Johnson (1943: 7) gave the mathematical formula for this index. In the present paper *miurus* is given a rating of 0, the more specialized *mollis* a rating of 100; therefore 50 is exactly intermediate. Ratings below 50 indicate a leaning toward *miurus*, above 50 a leaning toward *mollis*. Ratings below 0 or above 100 indicate that the character used is beyond the limits of the character in *miurus* or *mollis* respectively.

2 For many years *S. mollis* was known as *S. gyrinus;* for change in specific name see Hubbs and Raney (1944: 25–26).

The following comparisons can be obtained from Table I:

(1) The body depth in the hybrid, with a rating of 60, is between the average body depths of the slender *miurus* and the deeper-bodied *mollis; nocturnus* averages more slender than does either species, with an index rating of —29.

(2) The head length of the hybrid, when measured on the right side and converted into thousandths of the total length, is 312.8; that of the left is 313.8, giving a 313.3 average. No index rating of the hybrid is given because of the slight difference in head lengths of *miurus* (312) and *mollis* (315) and possible error in measuring the hybrid head length so closely. The very short head of the average *nocturnus* gives a negative rating of —43.

(3) The eye length of the hybrid leans slightly toward the large-eyed *miurus,* having a rating of 42; the eye length of the average *nocturnus* is shorter, with a rating of 87, and therefore it approaches the small-eyed *mollis* in this character.

(4) The distance from snout to adipose origin of the hybrid has a rating of 68, and in this character approaches *mollis;* whereas the rating of *nocturnus* is 24, with an approach toward *miurus.* The distance from snout to adipose origin is difficult to measure in some specimens because of shrivelling of the fatty substance at the adipose origin; however, in many specimens the more posterior insertion of the adipose can be readily seen and compared with the more anterior insertion of *mollis.*

(5) The distance from adipose notch to caudal tip in the hybrid has a rating of 35; *nocturnus* has a rating of 15. This measurement is usually more accurate than is the preceding one, provided the tip of the caudal is not injured and the notch is distinct.

(6) The index ratings for the length of the longest nasal barbel are 53 for the hybrid and 45 for *nocturnus.* This similarity in nasal barbel lengths was a factor in our original identification of the hybrid as *nocturnus.* When compared with *mollis,* the short nasal barbel of *miurus* appears to be shorter than it actually is; this is because the *large* size of the eye of *miurus* results in the tip of the barbel extending only to, or slightly beyond, the posterior margin of the eye, whereas in *miurus* the *small* size of the eye results in the tip of the barbel extending a greater distance beyond the posterior edge of the eye. Measurement of a barbel was made with dividers and was taken from the posterior edge of the base of the barbel to its tip. Care was taken not to stretch the barbel unduly. The longest nasal barbel of a specimen was used whenever there existed a difference in lengths between the 2 barbels.

(7) The length of the dorsal spine of the hybrid approaches intermediacy between *miurus* and *mollis,* with a rating of 58; the length of dorsal spine of the average *nocturnus* is shorter than is the short spine of *mollis,* with a high rating of 147.

(8) The length of the left pectoral spine of the hybrid is intermediate between *miurus* and *mollis,* with a rating of 51; the length of the pectoral spine of the average *nocturnus* is shorter than is the short spine of *mollis,* with a high rating of 176. The right pectoral spine of the hybrid appears to have been broken previous to capture, and sufficient time had elapsed for the broken tip to have become rounded. Whenever a difference existed between

TABLE I

COMPARISON OF THE *S. miurus* x *S. mollis* HYBRID WITH THE PARENTAL SPECIES, AND COMPARISON OF *S. nocturnus* WITH *S. miurus* AND *S. mollis*

	miurus		hybrid		*mollis*		*nocturnus*		
	Range	(Ave.)	Proportions; count	Hybrid index	Range	(Ave.)	Range	(Ave.)	Proportions count
Standard length, mm.	41.2–49.3	(44.8)	45.0	—	40.1–50.3	(44.4)	39.3–51.4	(44.5)	—
Thousandths of standard length									
Body depth	182–216	(197)	218	60	211–243	(232)	169–212	(187)	–29
Head length	300–331	(312)	313	—	302–341	(315)	286–316	(302)	–43
Eye length*	71–82	(78)	62	42	37–43	(40)	35–51	(45)	87
Distance, snout to adipose origin	598–659	(627)	566	68	498–565	(538)	555–650	(606)	24
Distance, adipose notch to caudal tip	344–404	(375)	400	35	396–469	(447)	337–474	(386)	15
Nasal barbel length*	99–127	(113)	140	53	144–178	(164)	98–161	(136)	45
Dorsal spine length	124–177	(155)	133	58	99–135	(117)	77–111	(99)	147
Pectoral spine length*	173–224	(197)	176	51	133–185	(156)	100–140	(125)	176
Number of barbs on pectoral spine	5-7	(6)		5	0–0	(0)	0–0	(0)	

* The longest measurement was used if a difference existed between lengths of the eyes, 2 nasal barbels, or 2 pectoral spines.

the lengths of the 2 pectoral spines of an individual, the longest spine measurement was used.

(9) In the hybrid there are indications of 5 barbs on the posterior edge of each pectoral spine, of which only the 2 central barbs of each spine are well developed. None of the barbs is as large as are the well-defined, retrorse barbs (average 6.3 per spine) in *miurus*. There are no barbs on the posterior edges of the spines of *mollis* or *nocturnus*. The anterior edges of the pectoral spines are smooth in the hybrid and *miurus;* they are usually smooth in *mollis,* although occasional specimens show a slight roughening near the tip; in *nocturnus* the anterior edges are roughened, serrated, or contain small, retrorse barbs throughout their lengths.

The differences between the hybrid and the presumed parental species, and its intermediacy, which were numerically demonstrated above, are well shown in the figures on Plate I: they are, depth of body, size of eye, positions of adipose fin insertion and adipose notch, length of nasal barbel, lengths of dorsal and pectoral spines, shape of head, and size of reduced number of barbels on the pectoral spine.

In addition Plate I illustrates:

(10) Intermediacy in the color pattern, and in lateral and diagonal streakings of the hybrid. The pattern is strongly defined in *miurus;* it is lacking in *mollis* except for the faint markings on the dorsal surface and sides of the head. In *miurus* the dark lateral and diagonal streakings (the myotomes between the muscle bands) are extremely faint or lacking; both lateral and diagonal streakings are plainly evident in *mollis*.

(11) Intermediacy in shape of head of hybrid when viewed from above. The head of *miurus* is squarish and angular; the head of *mollis* is rounded.

(12) Intermediacy in position of lower jaw of hybrid. The lower jaw of *miurus* is definitely included; in *mollis* the lower jaw is equal in length to the upper jaw. The position and shape of the lower jaw of the hybrid are identical with the position and shape of the lower jaw of *nocturnus;* this marked similarity was an important factor in our original identification of the hybrid as *nocturnus*.

(13) Intermediacy in shape of dorsal fin of hybrid. In *miurus* the anterior rays are longest; in *mollis* the posterior rays are the longest. The hybrid also shows, on the distal half of the anterior rays of the dorsal fin, a faint dusky spot, representing the pronounced dusky spot in *miurus*. The spot is absent in *mollis*.

(14) Intermediacy in anterior flexure of the lateral line in the hybrid. In *miurus* the axial streak usually is only slightly flexed anteriorly; in *mollis* the greater flexing generally produces a pronounced arch. The flexing of the axial streak, however, varies greatly in different individuals of both species, and in an occasional specimen of *miurus* appears to be as greatly arched as in the average *mollis,* whereas in an occasional *mollis* the axial streak is as little arched as in the average *miurus*.

Discussion

Recent work on the intermediacy of hybrids between their parental species strongly emphasizes the more or less exact intermediacy of the hybrids (Hubbs and Hubbs, 1932: 427; Hubbs, 1940; 205-07; Raney, 1940:

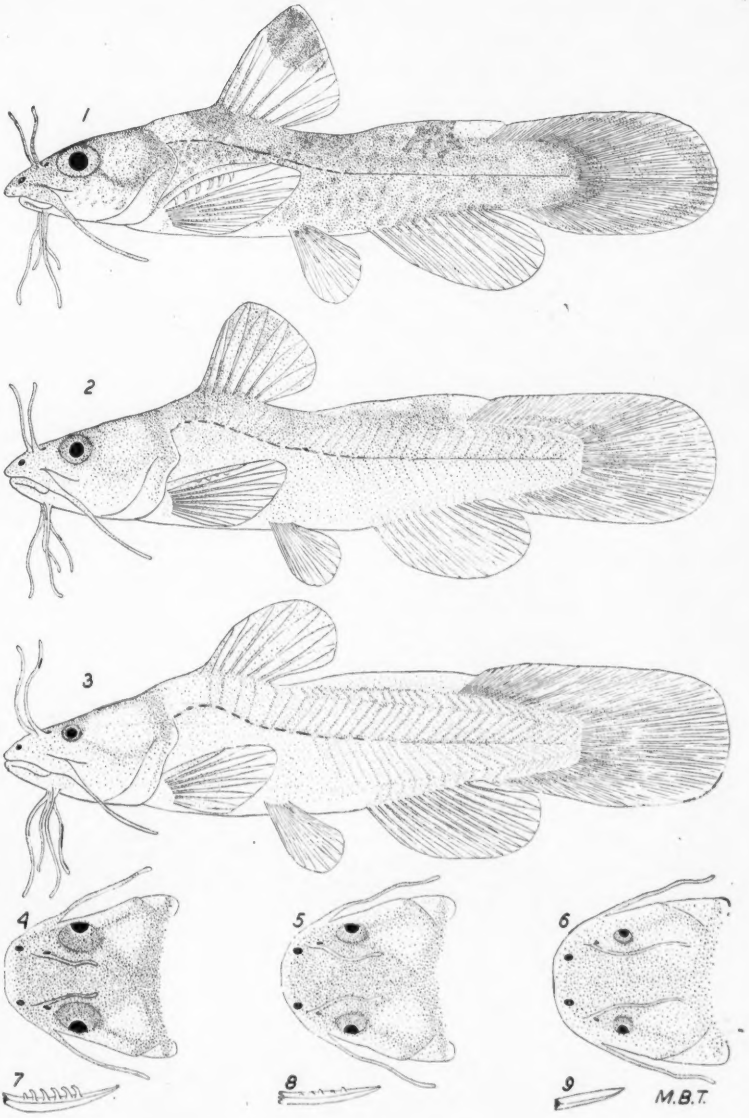

Fig. 1 is drawn from a female *miurus*, 41.3 mm. in standard length; Fig. 4, head of same female, viewed from above, and Fig. 7, the pectoral spine.

Fig. 2 is drawn from the hybrid, a female 45.0 mm. in standard length; Fig. 5, head of same female, viewed from above, and Fig. 8, the pectoral spine.

Fig. 3 is drawn from a female *mollis*, 43.0 mm. in standard length; Fig. 6, head of same female, viewed from above, and Fig. 9, the pectoral spine.

All 3 females were approximately in the same stage of sexual development. All figures were drawn with the aid of proportional dividers.

271; Hubbs and Kuronuma, 1942: 276; Hubbs and Miller, 1943: 354; Hubbs, Hubbs, and Johnson, 1943: 12; and Hubbs, Walker, and Johnson, 1943: 19). It follows that hybrid index ratings should fall at or near 50, as they have for the present hybrid; and that a grand average of all ratings should be at or near 50. The present hybrid has a grand average of 52.43. Hubbs, Walker, and Johnson (1943: Tables II, IV, VI) show grand averages for some cyprinodont hybrid combinations which range from 42 to 66.

If a third species is substituted for a hybrid, as I have done with *nocturnus*, then index ratings may range widely and erratically, as they have with *nocturnus*, from —43 to 176. Grand averages may also range widely, but in *nocturnus* the wide-ranging indices counteracted each other, resulting in a grand average of 52.75. Although the grand averages of the hybrid (52.43) and *nocturnus* (52.75) are close to identical, it cannot be argued that they are the same form, because of the wide divergence in some of the index ratings for the same characters.

Data from Table I and Plate I refute the possibility that the hybrid may be an undescribed, northern form of *nocturnus*, and demonstrate that in several characters the hybrid approaches *miurus* and/or *mollis* more closely than it does *nocturnus*. Furthermore, Hubbs (1940: 209-10) has shown that in species of North American Ameiuridae, there is a south-north gradient in the lengths of the dorsal and pectoral spines. The spines of southern representatives of a species are longer than are the spines of representatives of the same species from the northern part of the range. If the hybrid were a subspecies of *nocturnus* (type locality, Saline River, Benton, Arkansas) the spines of the hybrid should be *shorter* than those of the typical subspecies, whereas they are notably *longer*.

The possibility that the hybrid is an undescribed, very distinct subspecies of *miurus* or *mollis* is likewise remote, since only the one specimen has been found in an area containing moderate or large populations of typical examples of *miurus* and *mollis*, and in an area where much collecting has been done.

The possibility is also remote that the hybrid is a mutant of *miurus* or *mollis*, which, by a set of miraculous circumstances, has all of its characters (14 of which have been discussed in detail) more or less exactly intermediate.

From the evidence, the only logical conclusion is to assume that the specimen in question is a hybrid between *miurus* and *mollis*.

Explanation for the Hybrid Catfish

From my unpublished studies in Ohio of the distribution and ecology of hybrid combinations among catostomids, cyprinids, percids, and centrarchids, I am convinced that hybridization within these groups is a direct response to environmental conditions. Among centrarchids, particularly in lotic water, hybridization is often a result of overcrowding during spawning, generally because of too little spawning ground for the number of spawners present, or because of sub-marginal spawning habitat. Among some hybrid combinations of stream-inhabiting cyprinids, such as *Notropis cornutus* x *Notropis rubellus*,[3] hybrids appear to be the result of spawning by the parent species in more swiftly flowing water than that in which these species normally spawn. In the percid combination, *Hadropterus maculatus* x *Percina ca-*

prodes,[3] hybrids appear to be the result of spawning by the parent species in streams having lower gradients, where riffles are more poorly developed, rather than in those sections of streams with well-developed riffles where the parent species usually spawn.

If the creation of hybrids in streams were entirely the result of chance, then hybrids could be expected to occur wherever both parent species spawned in close proximity to one another. This is not the case with the hybrid combinations mentioned above, for these hybrids have clear-cut distributional patterns. The distributional pattern of the *cornutus* x *rubellus* hybrid is enclosed within the limits of the distinctive pattern made by those Ohio streams, or portions thereof, having very high gradients. Since the parental species spawn in streams of moderate gradients as well as high, the distributional pattern of both parents is more general and extensive than is that of the hybrid.

In high gradient streams there is a breaking down of those ecological barriers that separate the parent species in streams of lower gradient, thereby forcing some indivduals of the species to intermingle during the act of spawning or forcing groups of both species to spawn in unusually close proximity to each other in sub-marginal habitats. When stream conditions which result in creation of *cornutus* x *rubellus* hybrids are recognized, one can predict with a fair degree of accuracy where hybrids will occur and where they will be found attempting to spawn with one or both parents.

Concerning the *miurus* x *mollis* hyrid: In most parts of Ohio, *miurus* and *mollis* are well separated ecologically during spawning. Both species spawn in May, June and July. *S. miurus* spawns in those parts of streams having well-developed riffles, or pools of flowing water, and having gradients of more than 3 feet per mile. The egg clusters are deposited under rocks, logs, boards, or similar objects, in situations where the flowing water keeps the firm, clean bottom free of silt deposits. *S. mollis* spawns in portions of streams having very low or base gradients, or in lenitic waters such as ox-bows, glacial pot-hole lakes or artificial impoundments, where the bottom is of muck, mud, or organic debris, with or without aquatic vegetation. The egg clusters are deposited beneath boards, logs, tin cans, in crayfish burrows, holes in the mud, or under roots of vegetation. In these waters gradient and type of bottom appear to be the principal ecological factors in separating the two species during spawning.

Along the shores and in the bays of southwestern Lake Erie, definite ecological barriers between the two species more or less break down. Occasionally over a clean bottom one will find a spawning pair of *miurus*, or a parent guarding an egg cluster, while only a few feet distant over a muddy bottom there might be a pair of spawning *mollis* or a parent guarding an egg cluster.

Ecological barriers appear to be completely lacking in the silt-laden streams of basic and low gradients that empty into the southwestern end of Lake Erie. In these streams *miurus* spawns under suitable objects where the sluggish current is barely perceptible, and the gravelly or sandy bottom

[3] *Notropis cornutus* (Mitchill), common shiner; *Notropis rubellus* (Agassiz), rosy-faced shiner; *Hadropterus maculatus* (Girard), black-sided darter; *Percina caprodes* (Rafinesque), log-perch darter.

is partly overlaid with silt. *S. mollis* spawns under suitable objects in lenitic water and sometimes adults of the two species may be spawning or guarding egg clusters only a foot distant from each other. Upon one occasion I found, under a board 5 feet long, a parent *miurus* guarding an egg cluster under the end that was in lotic water, and 2 adults of *mollis* guarding egg clusters under the shore end of the board in lenitic water.

Since in southwestern Lake Erie and its adjacent low gradient streams the two species spawn in very close proximity to each other, it appears plausible that a lack of ecological barriers may have resulted in the production of a natural hybrid.

It is probably significant that in Ohio the percid hyrid, *Hadropterus maculatus* x *Percina caprodes*, has been found only in the shallow waters of southwestern Lake Erie, and in turbid streams of very low or base gradient, such as the streams that enter the southwestern end of the lake. In such waters there appears to be a distinct break-down in those ecological barriers, found in streams of moderate gradient, which separate the spawning adults of the two species. In streams of moderate gradient, *H. maculatus* spawns in pools that have an obvious current and a sandy or gravelly bottom; *P. caprodes* spawns on those parts of well-developed riffles that have a bottom of sand and fine gravel. In the low-gradient streams, a principal spawning niche for both species, obviously sub-marginal, is the poorly-developed riffles with a barely preceptible current which flows over sand mixed with silt. In such spawning areas pairs of adults of both species can be found spawning, or the males guarding territory, within a foot of each other.

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The Contribution of the Columbia River System to the Fish Fauna of Nevada: Five Species Unrecorded from the State[1]

By ROBERT R. MILLER and RALPH G. MILLER

INTRODUCTION

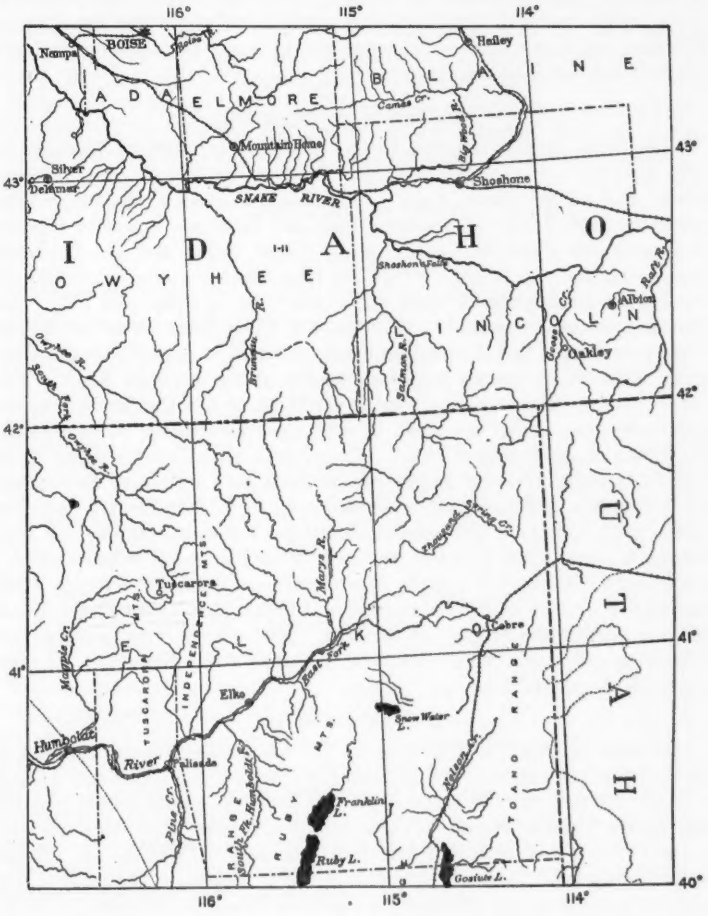
WITHIN the borders of the State of Nevada are five major drainage systems: the Lahontan, the Colorado, the Columbia, the Bonneville, and the Death Valley. With few exceptions, the fish fauna of each of these systems is highly distinctive. The Lahontan system, which is enclosed and occupies a large part of central Nevada, has the richest fauna, made up of 12 species comprising about 30 forms. The Colorado (including the Pleistocene tributary White River of eastern Nevada) forms the southeastern boundary of the state and contributes 15 species, but only about 20 forms. The Columbia, lying along the northern border of Nevada, contributes at least 10 species, of which two—the minnows *Rhinichthys osculus*[2] and *Richardsonius balteatus*—also occur in the Bonneville. That system has a rich fish fauna but, as it barely enters the eastern edge of the state, it contributes only 4 species. The Death Valley system is found in Nevada only in southern Nye County, where four endemic species inhabit desert springs.

There are a number of other, generally small, isolated drainage basins in Nevada, each containing a distinctive though meager fish fauna. All of these drainages are mapped and their fish life is discussed by Hubbs and Miller (1948 *a-b*), and by Miller (1946, 1948).

No general, systematic treatise of the native fish life of Nevada has appeared since the classical contribution on Lahontan fishes by Snyder (1917). Pertinent literature references on the taxonomy of Nevada fishes not included in that report, or published subsequently, are by Cope and Yarrow

1 Published by permission of the Secretary, Smithsonian Institution.
2 The forms of *Rhinichthys* (subgenus *Apocope*) in the West exhibit so much overlapping in their characters that most of the nominal species are now regarded as comprising a single, wide ranging species, *R. osculus* (Girard). This species inhabits all of the major drainage systems of Nevada.

(1875), Gilbert (1893), Snyder (1921), Wales (1930), Hubbs (1932), Hubbs and Miller (1941, 1948 *a-b*), Tanner (1942) and Miller (1945, 1948). The introduced species were recently treated by Miller and Alcorn (1946).



Map 1.—Northeastern Nevada and adjoining regions, to illustrate the drainage of the Columbia River system. Photographed from Map No. 23 of Lawson, Gilbert, *et al*, 1908. Retouched by Mrs. A. M. Awl.

From 1934 to 1946 intensive collecting was carried out in Nevada, principally by expeditions from the University of Michigan. Until recently, however, the northeastern portion of the state draining into the Snake River,

and hence part of the Columbia River system, has remained unexplored by ichthyologists. In the fall of 1945, J. R. Alcorn, then with the U. S. Fish and Wildlife Service stationed at Fallon, collected on the East Fork of the Owyhee River and obtained the first record of *Catostomus columbianus* for Nevada, as detailed below. In August, 1947, the junior author (who recently celebrated his 76th birthday) made 8 collections in the Owyhee, Bruneau, and Salmon river drainages, adding four additional species to the recorded fish fauna of the state.

Description of Drainages

The three major Columbia River tributaries in northern Nevada are, from west to east, the Owyhee River, the Bruneau River and the Salmon River, also called Salmon Falls Creek (Map 1). All enter Snake River below the great barrier of Shoshone Falls and hence would not be expected to support the distinctive fauna of the Upper Snake and the Bonneville basins (Hubbs and Miller, 1948*a*: 30, and references cited therein). Although the headwaters of these three rivers lie in close proximity, their mouths are widely separated. The Owyhee River flows northwest through Idaho into Oregon and then swings north-northeast to enter the Snake River about 90 miles by stream below the mouth of the Bruneau River. That stream flows north into Idaho, veering northwest to join the Snake. Salmon River also flows north into Idaho to enter the Snake almost 90 miles above the mouth of the Bruneau River. The average annual precipitation of the region is usually 12 to 15 inches, but in the higher mountains it is greater than 15 inches, and in the drier sections only 8 to 12 inches fall each year (Hall, 1946: fig. 3). The general elevation of the area drained by these streams is about 5,300 to 7,100 feet, with the higher peaks varying between 8,000 and 9,000 feet. Yet to be investigated are the Little Owyhee River, just to the west of and tributary to the Owyhee, and Goose Creek in the extreme northeastern corner of Nevada. That stream may yield a very interesting fish fauna since its mouth in Snake River lies about 40 miles above Shoshone Falls.

Acknowledgments

We wish to thank the officials of the Nevada Fish and Game Commission for their fine co-operation, and are also grateful to J. R. Alcorn and Richard G. Miller for their interest and assistance. Reeve M. Bailey kindly provided data for the Nevada records of *Richardsonius balteatus hydrophlox* deposited at the University of Michigan Museum of Zoology (UMMZ), and William Ralph Taylor made the anal ray counts for these specimens (Table IV). The other collections are all deposited in the U. S. National Museum (USNM) and were taken in Elko County, Nevada (Map 1).

All of the species discussed can be readily identified by using the keys published by Schultz (1938).

Family Catostomidae

Catostomus macrocheilus Girard

Catostomus macrocheilus Girard, Proc. Acad. Nat. Sci. Phila., 8, 1856: 175. Type locality, Astoria, Oregon.

The coarse-scaled sucker of the middle and lower Columbia River, and certain coastal streams of Oregon, was obtained at only two localities in Nevada: USNM No. 146030, 3 young to adult, were collected by Ralph G. Miller, Mr. and Mrs. Richard G. Miller, and assistants, on August 17, 1947, from the South Fork of the Owyhee River, about 4 miles east-northeast of Tuscarora; and USNM No. 146044, 132 young to small adults, were seined by R. G. Miller and assistant on August 18, 1947, from the Salmon River, about 7 miles northeast of Contact and just west of San Jacinto.

These 135 specimens agree in scale and fin-ray counts and in general body shape and lip structure (Hubbs, Hubbs and Johnson, 1943: pl. 2, fig. 1*a*; pl. 6, figs. 1*a* and 2*a*) with other representatives of this widespread species. The dorsal rays number 12 to 15, usually 13 or 14, and the lateral line scales range from 62 to 79, usually 66 to 74 (Tables I and II).

TABLE I

NUMBER OF DORSAL RAYS IN TWO SPECIES OF *Catostomus* FROM NEVADA

Drainage and Species	Number of Dorsal Rays					No.	Ave.
	11	12	13	14	15		
Owyhee River							
C. macrocheilus	..	..	1	2	..	3	13.67
C. columbianus	23	79	7	..	..	109	11.85
Salmon River							
C. macrocheilus	..	2	17	33	8	60	13.78
C. columbianus	43	46	1	2	..	92	11.59
Bruneau River							
C. columbianus	9	33	5	..	..	47	11.91
Totals							
C. macrocheilus	..	2	18	35	8	63	13.78
C. columbianus	75	158	13	2	..	248	11.77

The habitat of these suckers was typical of the usual environmental predilections of species of *Catostomus*. On the South Fork of the Owyhee River, which was 20 feet wide where seined, there were many abandoned beaver dams where the water was up to 4 feet deep and the current was moderate. The water temperature was 68° F. On the Salmon River, pools were 8 × 15 feet in major dimensions, the water was up to 3 feet deep, the current was moderate, and the temperature was 74° F.

Hybridization between this species and *Catostomus columbianus* is discussed under the account of that species which follows.

Catostomus columbianus (Eigenmann and Eigenmann)

Pantosteus columbianus Eigenmann and Eigenmann, Amer. Nat., 27, 1893: 151, 152. Type locality, Boise River, Caldwell, Oregon [= Idaho].

Catostomus syncheilus Hubbs and Schultz, Univ. Wash. Publ. Biol., 2 (1), 1932: 6-10. Type locality, Crab Creek, about 7 miles below Odessa, Washington.

The nomenclature adopted for this species, currently called *Catostomus syncheilus*, has resulted from a study of the types of *Pantosteus columbianus*

TABLE II

NUMBER OF LATERAL LINE SCALES IN TWO SPECIES OF *Catostomus* FROM NEVADA

Drainage and Species	Number of Lateral Line Scales										No.	Ave.*
	62–65	66–69	70–73	74–79	92–95	96–99	100–103	104–107	108–111	112–114		
Owyhee River												
C. macrocheilus	1	1	..	..	..	..	..	..	..	..	2	65.00
C. columbianus	..	..	..	..	2	3	6	3	3	..	17	102.00
Salmon River												
C. macrocheilus	2	6	9	4	..	..	..	..	..	..	21	70.29
C. columbianus	..	..	..	..	..	..	1	2	4	3	10	108.90
Bruneau River												
C. columbianus	..	..	..	..	1	1	..	4	1	..	7	102.86
Totals												
C. macrocheilus	3	7	9	4	..	..	..	..	..	..	23	69.83
C. columbianus	..	..	..	..	3	4	7	9	8	3	34	104.21

* Computed from the original, unclassed data.

and the discovery that they do not represent a species of *Pantosteus*. *P. columbianus* was based on 3 cotypes, one of which is still in this country and the other 2 are at the British Museum. The cotypes at that institution were kindly examined for me by Dr. Rolf Bolin and Dr. N. B. Marshall and their data are summarized herein (Table III). The absence of a notch at the corners of the mouth between the upper and lower lips (feebly developed on one side in the National Museum cotype) conclusively eliminates the reference to *Pantosteus*, for these notches are prominently developed in specimens of *P. jordani* as small as 50 mm. standard length. Other characters also confirm the transfer to *Catostomus* (Table III). *Pantosteus columbianus* must therefore be removed from the synonymy of *Pantosteus jordani* Evermann, where it has been placed for over 50 years.

TABLE III

COMPARISON BETWEEN *Pantosteus jordani*, THE TYPES OF *Pantosteus columbianus*, AND *Catostomus syncheilus*

	*Pantosteus jordani**	3 cotypes of *Pantosteus columbianus*†	*Catostomus syncheilus*§
Character			
Dorsal rays	10 or 11	12 13 12	10–14 (11 or 12)
Notch at mouth corners	strongly developed	absent or weak	absent or weak
Scales in lateral line	79–89	103 91–94 76–80	88–124
Predorsal scales	43–50	61 54–58 47	46–75 (63 or 64)
Scales above lateral line	15–20 (17 or 18)	21 18–21 16–17	16–27 (20–22)
Scales below lateral line	9–12 (11)	13 10–12 11–12	11–17 (13–15)
Scales around caudal peduncle	23–29 (25–28)	32 26–30 24–26	27–38 (31–33)

* First 3 characters based on examination of numerous specimens from the Columbia River basin in the U.S. National Museum. Data for last 4 characters taken from Hubbs, Hubbs and Johnson (1943, tables 34–37).

† First specimen is USNM No. 125261, 77.5 mm. standard length; second and third specimens are, respectively, 79.2 mm. and 72.5 mm. standard length, and are deposited in the British Museum as number 1893. 2. 7. 647–8.

§ The data in this column represent the results of the present study combined with the counts given by Hubbs, Hubbs and Johnson (1943).

The data in Table III indicate that the 3 cotypes do not represent a single species. Two are identical with *Catostomus syncheilus* but the smallest cotype, which we have not seen, may possibly represent a hybrid between *Catostomus columbianus* and *C. macrocheilus*. In order to establish definitely the identity of *C. columbianus*, we hereby designate as lectotype the cotype in the National Museum (USNM No. 125261), a specimen 77.5 mm. standard length and about 99.5 mm. total length (caudal fin broken). It agrees in every respect with *Catostomus syncheilus* and its meristic characters are listed in Table III (first specimen in column two).

This fine-scaled sucker of the middle and lower Columbia River basin is represented in 7 collections from northeastern Nevada as follows: USNM No. 132186, 15 young to small adults, collected by J. R. Alcorn on September 3, 1945, from the upper end of Wild Horse Reservoir on the East Fork of the Owyhee River, about 55 airline miles north of Elko; USNM No. 146031,

3 small adults, from the South Fork of the Owyhee River at the same station as that listed under the account of *C. macrocheilus*; USNM No. 146034, 186 young to adults, seined by Ralph G. Miller and Richard G. Miller on August 17, 1947, from Deep Creek, tributary to the South Fork of the Owyhee River, about 17 miles by road south of White Rock; USNM No. 146041, 6 young to adults, obtained by the same collectors on the same day, from Bull Run Creek, tributary to the South Fork of the Owyhee River, about 6 miles south of White Rock; USNM No. 146046, 92 young to adults, obtained from the Salmon River at the same station as listed under the records for *C. macrocheilus*; USNM No. 146065, 29 young to half grown, seined by Ralph G. Miller and assistant on August 20, 1947, from the Bruneau River, 7 miles east of Gold Creek; and USNM No. 146068, 18 young to adult, taken by the same collectors on the same date, from the headwaters of the Bruneau River at the first bridge crossing on the road northward from Deeth.

All of these specimens have the characteristic lip structure of the species (Hubbs, Hubbs and Johnson, 1943: pl. 2, fig. 1*c*; pl. 6, figs. 1*c* and 2*c*) and are most readily separated from *C. macrocheilus* by the finer scales (92 to 114) as well as by the fewer dorsal fin rays (Tables I and II).

In contrast to *C. macrocheilus*, the usual habitat preference of *columbianus* is for the more swiftly flowing portions of streams. At each of the four collecting stations where the junior author secured this species, but not *macrocheilus*, he noted that the current was swift, and that the bottom was composed of boulders, rocks or gravel, except on the headwaters of the Bruneau River where the current was moderate and the bottom consisted of mud and sand. This station, however, was at a high elevation, only 4 miles north of the pass separating this portion of the Columbia system from that of the Lahontan basin, and the water was cold, only 60° F. (air 74° F.).

Specimens interpreted as hybrids between *C. macrocheilus* and *C. columbianus* have been recorded by Hubbs, Hubbs and Johnson (1943: 19-33, pl. 2, fig.1*b*; pl. 6, figs. 1*b* and 2*b*). In the collection from the Salmon River near San Jacinto, where the two species were taken in numbers (132 *macrocheilus* and 92 *columbianus*), 4 intermediate specimens were found (USNM No. 146045). In these, the dorsal rays number 11 to 13 (2 with 12), and the scales vary from 80 to 89—just bridging the gap between the scale counts recorded for the two presumed parent species (Table II). In lip structure these 4 specimens are also intermediate.

Two subspecies of *Catostomus columbianus* have been named. The Palouse River form of eastern Washington, *C. columbianus palouseanus* Schultz and Thompson (1936), has been distinguished by its smaller scales and fewer dorsal rays from the typical form, *C. c. columbianus*, known elsewhere in the Columbia River system. Hubbs, Hubbs and Johnson (1943: 20, footnote to Table IV) hinted, however, that the species may really represent a complex of several subspecies. An inspection of their data on proportions (Tables VI and X) shows that, for comparable size groups (first column in each table), *columbianus* differs further from *palouseanus* in having a slenderer body, a greater distance between dorsal fin and occiput, a somewhat slenderer caudal peduncle and a somewhat shorter snout. In Table XXIII,

however, their data for the number of lateral line scales in *palouseanus* greatly lessens the difference in this scale number between the two subspecies; for Schultz and Thompson (1936) recorded a variation of 104 to 121, average 113.8, whereas Hubbs, Hubbs and Johnson gave the range as 90 to 124, average 105.2. *C. c. columbianus* has 88 to 115, average about 102, lateral scales, according to the data of all five of these authors. The number of these scales recorded for our material of *columbianus* (92 to 114, average 104.2) tends even more closely to bridge the gap in this character between the two subspecies, but the number of dorsal rays (11 to 14, average 11.77) agrees well with the data published for *columbianus*. We therefore tentatively assign our material to *C. c. columbianus*, but the final allocation must await detailed counts and measurements of these and hundreds of other specimens of *C. columbianus* throughout its range.

Family Cyprinidae

Ptychocheilus oregonensis (Richardson)

Cyprinus (*Leuciscus*) *oregonensis* Richardson, Fauna Bor.-Amer., 3, 1836: 305. Type locality, Columbia River.

The Columbia River squawfish was seined at two stations in Nevada: the South Fork of the Owyhee River, about 4 miles east-northeast of Tuscarora, and the Salmon River, about 7 miles northeast of Contact. The full data for these localities are given under the account of *Catostomus macrocheilus*. The Owyhee River specimens, USNM No. 146029, comprise 9 yearling to small adults; the Salmon River specimens, USNM No. 146047, number 122 young to adults.

This is one of the most distinctive and widespread species in the Columbia basin and is easily recognized by its pike-like body and by the elongated lower arms of the pharyngeal bones. That this species is commonly caught and discarded by anglers was evident from the skeletons that were seen all along the banks of the Jarbidge River, between its junction with the Bruneau River and the town of Jarbidge.

Acrocheilus alutaceus Agassiz and Pickering

Acrocheilus alutaceus Agassiz and Pickering in Agassiz, Amer. Jour. Sci. Arts, 19, 1855: 99. Type locality, Williamette Falls, Oregon, and Walla Walla River, Washington.

The chiselmouth was collected at only one locality in Nevada, the Salmon River, about 7 miles northeast of Contact. Here it was associated with *Catostomus macrocheilus, C. columbianus, Ptychocheilus oregonensis, Richardsonius balteatus* and *Rhinichthys osculus*. The large pools along the river yielded 108 young to adults (USNM No. 146051).

This monotypic genus is strikingly distinguished by the prominent, sharp-edged horny sheath on the lower jaw. The long, very convoluted intestine, filled with vegetable debris, clearly indicates the herbivorous diet of the species and the specialized jaw is evidently an adaptation for such feeding habits.

TABLE IV

VARIATION IN NUMBER OF ANAL RAYS IN POPULATIONS OF *Richardsonius balteatus* FROM NEVADA

Catalogue Number and Locality*	Number of Anal Rays									No.	Ave.
	9	10	11	12	13	14	15	16	17		
COLUMBIA BASIN:											
S. Fk. Owyhee River											
USNM 146026 near Tuscarora	..	..	..	3	18	23	9	3	2	58	13.95
USNM 146037 Deep Creek	..	..	4	10	20	18	5	1	..	58	13.22
USNM 146042 Bull Run Creek	..	..	1	16	17	12	5	..	..	51	13.08
Salmon River											
USNM 146050 near Contact	..	..	3	9	20	26	7	3	..	68	13.50
E. Fk. Owyhee River											
USNM 132189 Wild Horse Reservoir	1	7	25	27	5	..	..	..	..	65	11.43
Bruneau River											
USNM 146067 near Charleston	..	7	26	5	..	..	..	..	..	38	10.95
USNM 146071 headwaters	1	23	37	13	..	..	..	..	..	74	10.84
BONNEVILLE BASIN:											
UMMZ 132197 Thousand Spr. Creek	..	7	36	9	..	..	..	..	..	52	11.04
UMMZ 124783 Big Sprs. Creek	1	15	51	12	..	..	..	..	..	79	10.94
TOTALS											
Intergrades†	..	..	8	38	75	79	26	7	2	235	13.45
R. b. hydrophlox	3	59	175	66	5	..	..	..	..	308	11.04

* USNM = U.S. National Museum. UMMZ = University of Michigan Museum of Zoology. See text for exact localities.
† Intergrades between *R. balteatus balteatus* and *R. b. hydrophlox*. All above the solid line are regarded as intergrades, those below it as *R. b. hydrophlox*.

Richardsonius balteatus (Richardson)

Cyprinus (Abramis) balteatus Richardson, Fauna Bor.-Amer., 3, 1836: 301. Type locality, Columbia River; presumably Fort Vancouver, Washington (*fide* Gilbert and Evermann, 1894: 46).

Although it has been known for some time that the redside shiner occurs in Nevada, this fact has not been recorded. It was first taken by Carl L. Hubbs and family on September 14, 1934, in Thousand Spring Creek (Map 1), 23 miles by road above Montello (T.42N., R.67E.), Elko County, a tributary of the Bonneville system; UMMZ No. 132197, 61 half-grown to adults. The species was next taken, also in the Bonneville system, by C. L. Hubbs, R. R. Miller and A. J. Calhoun in Big Springs Creek, in the southeastern corner of White Pine County (T.10N., R.70E.), on July 5, 1938; UMMZ No. 124783, 81 half-grown to adults. This fish is abundantly represented in the Columbia River basin of northeastern Nevada, for it was taken in 7 out of 9 collections which have been made in that area, comprising a total of 894 specimens (USNM Nos. 132189, 146026, 146037, 146042, 146050, 146067, and 146071).

The great variation in the number of anal rays in this ubiquitous species has been recorded by several investigators, principally by Gilbert and Evermann (1894), Eigenmann (1895), Evermann (1896), and Snyder (1908). The number varies from 9 to 22 with the general recognition (Schultz, 1938: 150) of two subspecies as follows: *R. b. hydrophlox* (Cope), 9 to 13 (usually 10 to 12) rays, and *R. b. balteatus* (Richardson), 13 to 22 (usually 14 to 18) rays. Intergrading populations (Table III) have from 11 to 17 (usually 12 to 15) anal rays. The subspecies *balteatus* is widespread in the Columbia River system below the great falls of the Snake River and also inhabits the Fraser River of British Columbia as well as coastal streams and lakes of Washington and Oregon. The subspecies *hydrophlox* occurs rarely below the Snake River falls as relict populations, but is common above the falls and in the now isolated Bonneville system. It has been introduced recently into the upper Colorado River basin (Simon, 1946: 81). Our material represents *R. b. hydrophlox* and intergrades between that subspecies and *balteatus* (Table IV).

Other Species of the Columbia River System

At least 4, and possibly 5 or 6, other species now inhabit, or previously were found in, the Columbia River tributaries of northern Nevada. Those definitely known from these streams are *Oncorhynchus tshawytscha, Rhinichthys osculus, Cottus beldingii,* and a species of *Prosopium.* In addition, trout (*Salmo gairdnerii* and *Salmo clarkii*) are now found in the region and one or both species were probably native and may still represent the native stock. Further field work and local inquiry should help in determining their status.

Oncorhynchus tshawytscha (Walbaum)

Salmo tshawytscha Walbaum, Artedi Gen. Pisc., 1792 (3): 71. Type locality, streams of Kamchatka.

As early as 1874, salmon were noted to come by the hundreds, in the spring and fall, to spawn in a small tributary of the South Fork of the Owyhee River, on the north slope of the Bull Run Mountains (F., G. A,. 1874). Gilbert and Evermann (1894: 199) determined through interviews with residents that salmon formerly reached the headwaters of Bruneau River, but that just prior to their studies an impassable dam had been constructed in the lower course of the river. Salmon were also seen by a resident in the extreme headwaters of the Owyhee River in Nevada. Whether chinook salmon still ascend this river was not determined by us.

Rhinichthys osculus (Girard)

Argyreus osculus Girard, Proc. Acad. Nat. Sci. Phila., 8, 1856: 186. Type locality, Babocomari River, Cochise County, Arizona.

The common western dace is represented in 7 out of the 9 collections made in northeastern Nevada. In order to allocate our material subspecifically, however, it will be necessary to revise the subgenus *Apocope*.

Cottus beldingii Eigenmann and Eigenmann

Cottus beldingii Eigenmann and Eigenmann, Amer. Nat., 25, 1891: 1132. Type locality, Lake Tahoe.

Until the status of the species of *Cottus* inhabiting western North America receives clarification, we apply the specific name *beldingii* to our material of this genus. Only two collections were obtained in Nevada (USNM Nos. 146033 and 146039), but sculpins are reported to be common in all the mountain streams. These specimens represent the same species that inhabits the Lahontan basin, but the forms inhabiting the Columbia River system will probably be separated subspecifically when carefully studied.

Prosopium, species

Two adults and 13 fingerlings of a whitefish of the genus *Prosopium* were collected in the Owyhee and Bruneau rivers (USNM Nos. 146040 and 146064). These specimens resemble both *P. williamsoni* Girard and *P. oregonium* (Jordan and Snyder), if that species is fully distinct. Preliminary comparison of our material with specimens of *williamsoni* and *oregonium* (including the types of *oregonium*, USNM Nos. 62987, 67005, and 75595) does not clearly indicate the status of the Nevada examples. Until further material is available and a more detailed comparison can be made, we prefer to postpone their specific allocation.

Salmo, species

There is little doubt that native trout once inhabited the Columbia River tributaries in Nevada, but whether any exist there now we are not prepared to say. The widespread stocking of both rainbow trout, *Salmo gairdnerii*, and cutthroat trout, *Salmo clarkii*, in Nevada (Miller and Alcorn, 1946) lessens the chances of finding a native stock. The name "Trout Creek," for a tributary of Salmon River east of Contact, is a convincing indication that trout once were (and still may be) native in the region.

The collections to date resulted in the capture of 24 fingerling to adults

of *Salmo gairdnerii*, but these probably represent planted fish. The lateral scale counts for 5 specimens varied from 127 to 141, which is very close to the counts given by Schultz (1938: 137) for *S. g. gairdnerii* Richardson. If we restrict this subspecific name to the fine-scaled steelhead trout, which inhabits the Pacific and ascends certain tributaries for spawning, our material then represents another form, perhaps *S. g. irideus* Gibbons.

As cutthroat trout are now being stocked in the Humboldt National Forest by the U. S. Forest Service (Miller and Alcorn, 1946: 177), the identity of any native subspecies of *S. clarkii* that may have lived in these streams will probably remain unknown. Furthermore, it is not unlikely that the form being stocked, *S. clarkii lewisi* (Girard), is the one which may have been the original inhabitant, for that subspecies is known to occur in the middle and upper Columbia system, as well as in Yellowstone Lake and the upper Missouri system. An old-timer contacted at Jacks Creek resort, on the South Fork of the Owyhee River, stated that 20 years ago he had caught cutthroat trout as long as 2 feet. Those inhabiting the region now are reported to attain scarcely a length of even 1 foot.

Summary

A brief discussion of the major drainage systems of Nevada and of the number of their fish species is given, followed by a description of the Columbia River tributaries of northern Nevada (Map 1). Five species heretofore unrecorded from Nevada are listed and their diagnostic characters are given. These species are: the suckers, *Catostomus macrocheilus* and *Catostomus columbianus* (tentatively, *C. c. columbianus*); and the minnows, *Ptychocheilus oregonensis*, *Acrocheilus alutaceus*, and *Richardsonius balteatus* (*R. b. hydrophlox*). Tables showing the variation in dorsal rays and lateral line scales are given for the two species of suckers, and counts of the number of anal rays in *Richardsonius balteatus* are presented. *Pantosteus columbianus* is shown to have been based on the species currently called *Catostomus syncheilus*; by priority, *syncheilus* falls as a synonym and *P. columbianus* is removed from the synonymy of *Pantosteus jordani*. Four presumed hybrids between *Catostomus macrocheilus* and *Catostomus columbianus* are briefly discussed. An undetermined species of *Prosopium* also is recorded. In addition, either *Salmo gairdnerii* or *Salmo clarkii* (or both) are regarded as having once inhabited the region, but their native occurrence there now is questionable. The generally overlooked records of salmon, *Oncorhynchus tshawytscha*, from northern Nevada are cited.

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Contribution to the Natural History of the Plethodont Salamander *Ensatina eschscholtzii*

By LESLIE MCKAY GNAEDINGER and CHARLES A. REED

THE discovery that the plethodont salamander *Ensatina eschscholtzii* lives on the campus of Reed College, Portland, Oregon, in considerable numbers, presented the opportunity to amplify our knowledge of its natural history, hitherto poorly known (see Storer, 1925; Dunn, 1926; and Bishop, 1943), but plans for an extended study had to be abandoned when both authors left Reed College. Thus the present survey covers only data obtained between September, 1945, and May, 1946; during this period 169 specimens were collected.

Reed College is in the southeastern part of Portland, Multnomah County, Oregon, at an approximate elevation of 150 feet. All specimens studied were from the sides of the "canyon," a shallow, swampy, unimproved depression running from east to west across the campus.

HABITAT AND POPULATION DENSITY.—Almost all of the salamanders were found on the south (north-facing) bank of the canyon. This area is densely wooded, mostly with Douglas fir *(Pseudotsuga taxifolia)*, western red cedar *(Thuja plicata)*, large-leaved maple *(Acer macrophyllum)*, and red alder *(Alnus oregona)*. There is little underbrush. For the greater period of our study the area was covered with a litter of leaves, twigs, and the dead remains of the previous year's small plants, with clumps of moss, each several square feet in area, scattered throughout. Towards spring a dense cover of ferns, flowering plants, and creeping vines grew through the litter and made the search for the salamanders more difficult. Throughout most of the period of the study the area was kept saturated by frequent rains.

The data as to habitat distribution presented in Tables I and II cannot

be regarded as exact, since no concerted effort was made to cover each situation an equal number of times and over equal areas. The tables indicate the importance of the moss habitat, seemingly hitherto overlooked for this species. The animals are between the moss and the ground, and are easily found when the moss is stripped off. Specimens found under ferns were always under the sword fern *(Polystichum munitum)*.

TABLE I

RELATIVE NUMBERS OF *Ensatina eschscholtzii* FOUND IN DIFFERENT HABITATS

Under moss	31.5%
Under leaves, grass, twigs	36.4%
Under dead fern fronds	7.7%
In decayed wood and under decaying logs	14.0%
Under a trash heap, mostly of tin cans	10.5%

The number of *Ensatina* in measured areas of different habitats were recorded. From one area of 45 sq. ft., covered with small bits of rotting wood derived from a decaying log, 12 salamanders were collected, the highest population density encountered. Some of these animals were found only by stripping off rotting slabs from the log. In contrast, in another area of 150 sq. ft., similar in nature, only 4 salamanders were found.

Search in the old dump of tin cans yielded one salamander for every 12 sq. ft. The density for all areas of the south side of the "canyon" was one salamander for each 38 sq. ft., although on one occasion only one salamander was found in 200 sq. ft. in a seemingly typical area. For any one type of habitat the variability in population densities found seems not to be correlated with any discoverable factors.

TABLE II

RELATIVE NUMBERS OF EACH AGE GROUP OF *Ensatina eschscholtzii* FOUND IN EACH HABITAT

Size of salamanders	Moss	Leaves, twigs, grass, etc.	Dead fern fronds	Decayed wood	Trash heap
Young	52.4%	19.0%	7.9%	15.9%	4.8%
Juvenile	16.7%	50.0%	8.3%	16.7%	8.3%
Adult	13.6%	50.0%	6.8%	9.1%	20.5%

SIZE AND GROWTH.— Specimens with tail injuries are excluded from this discussion. With regard to total length, the animals fell into two groups, those 24.0-40.5 mm., and those 52.0-129.0 mm. The smaller animals, which we assume to be first-year young, have a definite growth curve; those found in April are larger (32.5-40.5 mm.) than those captured in November (24.0-34.5 mm.). The larger animals (52.0 mm. and over), however, show no age groups, either when measured for total length or body length, and we assume that growth is so variable after the first year and a half that the age groups

overlap in size. We found no animals between 40.4 mm. and 52.0 mm.; we assume that salamanders finishing their first year and entering their second (May-September, for which period we have no data) would be of this size. Thus for animals more than one and one-half years old, we have no knowledge of rate or duration of growth.

The relation between the length of tail and the length of body (Table III) was calculated for four major groups: 1) the young, presumably of the first year (40.5 mm. and less, total length), for which sex cannot be determined without histological examination; 2) the juveniles (between 52.0 mm. and 85.0 mm., total length; 85.0 mm. is arbitrarily set); for these, sexual determination can sometimes be made externally, particularly in the larger individuals, but sex can usually be determined only by dissection; group 2 includes two subgroups: 2a) juvenile females, and 2b) juvenile males; 3) a group of adult females, 85.0 mm. and longer, total length; and 4) a group of adult males, 85.0 mm. and longer, total length. For reasons to be discussed, a group 4a is also presented, which is group 4 less one atypical individual.

All symbols are as defined by Simpson and Roe (1939).

TABLE III

LENGTH OF BODY (mm.) / LENGTH OF TAIL (mm.)

Group	N	Observed range	Mean	σ_m	σ	σ_σ	V	σ_v
1	58	59.6%–42.6%	51.9%	±0.5	4.0	±0.4	7.7	±0.7
2	37	96.0%–60.0%	75.5%	±1.13	6.9	±0.8	9.1	±1.06
2a	18	81.7%–60.0%	73.3%	±1.1	4.8	±0.8	6.5	±1.1
2b	4	80.2%–75.3%	77.7%	±1.15	2.3	±0.8	2.96	±1.05
3	11	83.6%–67.1%	78.5%	±1.4	4.6	±0.98	5.86	±1.26
4	18	153.5%–86.8%	100.6%	±3.3	13.9	±2.3	13.8	±2.3
4a	17	108.1%–86.8%	97.5%	±1.3	5.48	±0.94	6.5	±0.96

Study of Table III shows that the tail grows faster than the body; from a length hardly half that of the body in the young, the tail becomes more than three-fourths the length of the body in a typical adult female and more than a third of the males have tails longer than the body, with a mean tail length for adult males very near body length.

In one unusual adult male, the tail was more than one and one-half times as long as the body. The inclusion of this aberrant individual in group 4 gave to the group, from a statistical point of view, a somewhat unnatural appearance. The high mean, the high standard deviation, the high coefficient of variation, and the high standard errors for each of these are all to be attributed to the inclusion of this single specimen. For this reason, the data were also analyzed for group 4 without this individual and presented as 4a, which more nearly represents the normal variation in adult males.

The relation between body length and tail length is more variable than indicated in material hitherto published. The high variability in group 2, however, is undoubtedly attributable to inclusion in it of both sexes at a

period of individual growth when the relative tail lengths of the two sexes are beginning to differentiate. The low coefficient of variability in the males of subgroup 2b is thought to be without significance and due to the small sample. The data for subgroup 2a may not be very accurate, since the determination of sex is not positive.

Aside from the fact that tails of adult males become relatively longer than do tails of adult females, inspection reveals that the tail of the female is blunter, rounder, and more swollen.

Table IV indicates that there is little difference between the two sexes in body length.

TABLE IV

COMPARISON OF BODY LENGTHS OF ADULT MALES AND FEMALES

Group	N	Observed range	Mean	σ_m	σ	$\sigma\sigma$	V	σ_v
Adult ♂♂	18	58.4 mm.–45.5 mm.	50.6 mm.	±0.75	3.19	±0.53	6.3	±1.05
Adult ♀♀	11	60.8 mm.–50.8 mm.	53.4 mm.	±0.95	3.16	±0.67	5.8	±1.2

A comparison of the total lengths (Table V) of the same two groups indicates that the males, due to their relatively longer tails, have a greater average total length and a greater extreme total length than do the females. The longest male (128.8 mm.) was the one with the extraordinarily long tail, previously mentioned; no other male exceeded 117.0 mm. If this long-tailed male is disregarded, the mean total length for adult males is 100.1 mm.

TABLE V

COMPARISON OF TOTAL LENGTHS OF ADULT MALES AND FEMALES

Group	N	Observed range	Mean	σ_m	σ	$\sigma\sigma$	V	σ_v
Adult ♂♂	18	128.8 mm.–86.2 mm.	101.7 mm.	±2.3	9.63	±1.65	9.5	±1.6
Adult ♀♀	11	107.0 mm.–85.2 mm.	96.9 mm.	±1.9	6.34	±1.35	6.5	±1.4

Each young animal was weighed to one one-thousandth of a gram, each juvenile and adult to one one-hundredth of a gram. Each animal's weight was compared (Table VI) with its own total length to discover the relationship between growth in weight and growth in length. The groups are the same as for Table III.

As might be expected, the gain in weight, culminating in the adult females, is relatively greater than is the gain in length, in spite of the high growth rate of the tails. The relatively higher weights of the adult females as compared with those of the males are related to at least two factors—their greater absolute weight (Table VII), and their shorter, stouter tails. Weight, as might be expected, is a highly variable character at every age and size;

examination of our animals showed some long-tailed animals to be heavy, others thin, and vice versa.

TABLE VI

TOTAL LENGTH (cm.) / WEIGHT (grams)

Group	N	Observed range	Mean	σ_m	σ	$\sigma\sigma$	V	σ_v
1	21	12.05%- 4.1%	8.6%	±0.5	2.22	±0.34	25.8	±4.24
2	23	32.9%-12.6%	21.4%	±1.2	5.8	±0.85	27.1	±5.6
3	11	55.9%-27.7%	44.3%	±2.5	8.84	±1.8	19.1	±4.1
4	17	45.0%-14.8%	27.0%	±1.6	6.7	±1.15	24.8	±4.8

Although one male weighed 5.8 grams, which is more than any female, this was the extraordinary individual with the long tail; no other male weighed more than 4.1 grams. The greater average weight of the females may well be due in major part to the mass of eggs, which they were still carrying at the end of the study in mid-May.

TABLE VII

COMPARISON OF ABSOLUTE WEIGHTS IN GRAMS OF DIFFERENT GROUPS

Group	N	Observed range	Mean
1	23	0.05–0.49	0.26
2	37	3.28–0.70	1.60
3	11	5.08–2.58	4.30
4	19	5.80–1.45	2.80

SEXUAL DIFFERENTIATION.—Other than the differences in length and form of the tail, the sexes can be distinguished by the shapes of the naso-labial region and of the cloacal lips.

Males have paired swellings in the naso-labial region, which gives the upper lip, when viewed from below, a somewhat square appearance with a median notch. In lateral view, in specimens in which this feature is prominent, the swellings protrude anteriorly and ventrally beyond the lower jaw. The females do not have these swellings.

Another sexual difference is to be found in the cloacal region; in adult males the vent is longer and the cloacal lips more swollen than in adult females. In females heavy with eggs, late in April, the edges of the lips of the vent were somewhat swollen, but the lips themselves were not.

FEEDING AND FOOD.—Examination of the contents of stomach and intestines of 9 young, 6 juveniles, and 6 adults disclosed remains solely of arthropods, as follows: Crustacea (1 sowbug); Arachnida (2 mites, 17 spiders); 5 Diplopoda; 3 Chilopoda; and Hexapoda (24 Collembola, 4 Coleoptera, 2 dipterous larvae, 1 Thysanura, 1 Hymenoptera, and scattered lepidopteran scales in one specimen). Collembola and small spiders seem

to be the chief food. There is no noticeable difference between the food of younger and the older individuals.

Considering that many of the common millipedes have stink glands and that the centipedes have venom glands, their presence in the digestive tracts of the salamanders is somewhat surprising, and these creatures were not confined to the older salamanders.

A salamander kept without food for seven days yielded a small amount of material from the stomach and two small boluses from the intestine, but had a full rectum; only a collembolan from the rectum was identifiable. The rate of travel of material in the intestine and the rate of digestion appear to be slow.

Animals of all sizes were kept together without food for as long as three months without observable ill effects or loss of activity, nor did the larger individuals eat the smaller.

One adult male salamander, after eighteen days without food, was given a spider, a ladybug beetle, and a centipede. The salamander remained motionless until the centipede approached, then with a sudden movement of the head grasped it; the centipede appeared to pierce the salamander with its poison claws, whereupon the salamander released it. Twice again this action was repeated, after which the centipede crawled at will over the salamander. No attempt was made to eat the other two arthropods.

Swimming and Survival in Water.—When placed in water, *Ensatina eschscholtzii* swims by a series of writhings rather than by co-ordinated movements. The body and tail undulate laterally, but the tail is round and not adapted for swimming, and in general progress is slow and uncertain. The legs may or may not be used to supplement the body movements; sometimes when the animal has ceased writhing, the legs alone can be seen to move. The movements of the young are particularly unco-ordinated, and they may turn on their backs in their efforts to swim. At no time did any of the animals swim continuously; violent activity for a few minutes at a time alternated with periods of rest. They tend to sink when not active. No individual was ever seen to enter the water voluntarily but, if put into a pool, each would cling for days to any support offered and would not leave it to seek a better spot.

One young and one juvenile salamander were placed in a large vessel of water; the water was changed daily. Both swam violently for a few minutes, then sank to the bottom and remained motionless unless touched. After twelve hours the young failed to respond to touch stimuli, and was removed; it seemed to recover somewhat but subsequently died. The juvenile salamander lived under water for six days, remaining motionless, and then it, too, died.

Movement and Activity.—Three specific attempts were made to determine the rate and period of movement of *Ensatina eschscholtzii* in its natural environment. In each instance a number of animals were marked by clipping the toes and by scratching a numeral or letter on the ventral surface of each with a pin dipped in India ink. Although these latter marks are eventually lost due to shedding of the skin, they remained clear for several weeks.

For the first trial, February 8, 1946, 9 animals were released at 11:00 P.M. at one point in an area of decayed wood. The region was left undisturbed for 24 hours, when an area of 19 feet by 12 feet around the point of release was searched. Only one adult female was found, and this one was at the point of release. On February 28, 1946, 7 animals were released at 11:20 A.M. on the side of a hill covered by dead leaves, twigs, and grass. By 5:00 P.M. 2 of them, one a young one, had disappeared; 2 were found at the point of release; 2 were found about 7 inches away; and one was found 14 inches away. The following morning an area of 700 square feet around the point of release was searched thoroughly. One young was found 7 inches from the point of release, but none of the others were found, although 10 unmarked specimens were collected. This area had previously been searched on February 7.

On March 21, 1946, 10 salamanders were released at 12:00 M. at the same point of release used for the second group (Feb. 28). Five hours later the region was searched; one salamander had travelled 6 feet directly uphill and was found under a fern frond. One young had moved one foot directly uphill. Two others were found 7 and 3 inches away, respectively. The remainder were at the point of release. By 9:00 P.M. the individual found under the fern frond at 5:00 P.M. had moved 27 inches straight downhill; 2 others had moved 60 inches and 56 inches straight uphill, respectively. None of the others were found. The next morning an area of 18 by 10 feet around the point of release was searched. One salamander was found at the point of release, and one of those liberated on February 28 was found 68 inches from its original point of release. None of the rest were located. It seems that although there is some movement by day, most movement is at night; that the young are as active as the older animals; and that they usually either travel relatively far and fast, or push down into the soft earth so that they cannot be found.

When placed on the abnormal environment of a bare table-top, one of these salamanders may remain inactive for several minutes, or may make off immediately. When resting, the abdomen and thorax are in contact with the substrate, but when walking the legs are brought farther in, beneath the body, and only the tail drags, except in the young, which often have the chin rubbing. These animals have a relatively rapid, straight-forward walk, unaccompanied by lateral undulations of the body. When an animal reaches an edge, as of a table, it may change its direction to walk along it, or may stop; in no instance was one observed to walk directly off. After a moment's observation, however, the animal may spring from the table into the air, usually with such force as to clear the edge, tail and all. If the animal has its tail, it always lands on its feet; if the tail has been lost, it may fail to do so.

Only one salamander, a young individual, was found exposed to view; this specimen was on some moist leaves, on a gray winter day. Although most activity of these salamanders would seem to be at night, frequent nocturnal hunts with flashlights by both of us failed to find a salamander in the open at night, although several were found under the typical cover.

Salamanders kept in captivity, on the contrary, did not always seek

concealment. So long as the air of their glass container was sufficiently humid, salamanders would often be found exposed to view both day and night. Although the containers were never completely closed, it is probable that the available oxygen supply was low, which might explain their tendency to expose themselves. No change of color was observed as a result of such exposure.

Temperature of Environment.—A period of several days of subfreezing temperatures in December, 1945, gave an opportunity to note the effect of cold upon the activity of *Ensatina eschscholtzii*. Young were found active under moss, where the temperature was 1.2° C., and the temperature of the air -3.3° C.; they were also found to be active at 0.8° C. under dead leaves and fern fronds. The particular ground upon which the salamanders were found was not frozen and was protected by the cover under which the animals were concealed, although unprotected ground was frozen to a depth of half an inch or so, and the surface of the leaf litter and the moss was frozen almost to the depth at which the salamanders were found.

By accident, one container with salamanders was left outside on a window sill overnight during this cold weather. The next morning the salamanders were partially frozen and covered with a thin sheet of ice. One was completely stiff, one could barely move one leg, and one could move its head slightly; this last animal was only partially coated with ice, since part of the ventral surface was not covered. The salamanders were brought to room temperature slowly and four hours later had seemingly recovered, but one day later one had died, shedding its surface epithelium in the meantime. When dissected, it seemed to be normal except for air in the stomach. Two days later the other 2 died.

Apparently cold does not affect this species as long as the skin is not frozen; subsequent fatality, if the skin is frozen, may be the result of interference with respiration or of breakdown of the dermal tissues, including the rich network of dermal capillaries. Noble (1931: 420) states that some salamanders can survive freezing in a block of ice for a short period. We do not believe this would be true of *Ensatina eschscholtzii*.

No experiments were conducted to discover the animals' upper temperature limits.

Voice.—Like most salamanders, *Ensatina eschscholtzii* is usually nonvocal, but twice in the laboratory these animals have been heard to emit sounds. The first was from a specimen climbing over the hand of the investigator; the animal was seen to open its mouth widely, and a faint squeak was heard. On the second occasion, 3 specimens were made to emit noises by irritating the dorsal surface of the brachium by scratching them with a finger-nail. One male produced sound with a minimum of irritation, but the other two animals required considerably more. The sound may best be described as a puffing squeak, barely audible at 2 feet.

Associations.—No evidences of association with other animals were noted. Two instances, only, of association of pairs of adults of opposite sex were found; these occurred on March 1, 1946, and April 21, 1946. Specimens of different age groups were sometimes found together.

Hubbard (1903) fed specimens of *Ensatina* to garter snakes and to ring-

necked snakes under artificial conditions. Garter snakes are common in the "canyon," and may well prey on *Ensatina*, but we have no evidence for this. Specimens of *Ensatina* have elsewhere been found in burrows of various mammals.

Loss and Regeneration of the Tail.—Self-amputation of the tail (autotomy), when occurring, is at the constriction at the base of the tail, immediately posterior to the vent. The break takes place between vertebrae, and not across a centrum (Hubbard, 1903: 162). We have occasionally noticed slight bleeding, but usually there is none and the animal seems not to suffer even momentary shock. The tail will wriggle actively for several minutes, and occasionally for ten or fifteen minutes; if kept moist, it will respond to a touch or pressure stimulus by a lateral contraction for half an hour.

Hubbard (1903) states that *Ensatina* loses its tail by autotomy only under extreme provocation. This is not typical of our animals. Of the 169 salamanders collected, 4.9 per cent had recently lost their tails. Fourteen others of the 169 had partially regenerated tails, but it was soon realized that some of these were not regenerating from the base, but from various more distal points. Hubbard reports one such occurrence, and was puzzled by it; we can only agree with Hubbard that sometimes an *Ensatina* may have part of its tail bitten off or crushed. It is curious, however, that natural autotomy would not occur under such circumstances, for salamanders in the laboratory lost their tails if handled at all roughly; we soon learned, for instance, that such loss would invariably result within a short time if an animal were held suspended by the tail, and several lost their tails when we attempted to measure them without anesthesia.

Twice, in the laboratory, salamanders were found that had shed their tails in captivity for no known cause. In each instance the tailless animal and its tail were found in the container the following morning. One had a small cutaneous lesion upon the tail, hardly extensive enough to explain the loss, but the other appeared to be normal.

Reproduction.—Little is known of the reproductive behavior of *Ensatina eschscholtzii*. Eggs have been collected as early as April 19 (Van Denburgh, 1898) and as late as July 26 (Storer, 1925: 112); these latter, however, were in the limb-bud stage, and so had undergone considerable development. In our investigation, no eggs were found. Of 7 adult females collected April 21, 1946, 6 retained their eggs and one was without eggs; one adult female collected May 1, 1946, still had not laid her eggs; and females retained in the laboratory until May 15, 1946, had not laid their eggs. From this general evidence, we assume that egg-laying occurs later in northwestern Oregon than in California.

We collected our first young on November 1, 1945, indicating that development within the egg must continue over the summer and be finished before November.

Notes on the sizes of eggs from dissected females (Table VIII) show that an adult female collected early in the winter (December) had eggs as large as others collected in April and dissected in May, whereas another female collected in January had smaller eggs. All adult females, in addition

to their larger eggs, had numerous smaller eggs of the size typical for juvenile females (0.45 mm. and smaller).

Twice (March 1 and April 21) we found opposite-sexed pairs in nature, but with no indication as to whether or not these were chance associations.

TABLE VIII

SIZE OF FEMALES AND THE NUMBER AND SIZE OF THE EGGS FROM THEIR OVARIES

Date of dissection	Total length of female (mm.)	Diameter of large eggs (mm.)	Number of large eggs in each ovary	Number of small eggs in each ovary
Dec. 15	98.0	4.74	8 8	Not counted
Jan. 10	93.0	1.00–1.04		
Jan. 11	107.0	4.12	9 6	More than 30
Jan. 14	68.0			26 24
Jan. 21	102.8	2.9	8 7	Not counted
Feb. 17	62.6			14 16
May 15	107.8	4.00–4.5	6 8	Not counted
May 15	(Adult but tailless)	4.6–4.8	7 8	Not counted

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The Growth of Turtles in Lake Glendale, Illinois [1]

By Fred R. Cagle

THE addition to our fragmentary knowledge of the growth of reptiles requires intensive study of local populations. Such studies have been few because of the difficulties involved in collecting adequate samples, the scant return of data from a mark-release-recovery procedure, and the absence of techniques for the determination of age and growth history. The plastral growth rings of turtles provide a means of approximating the age and growth of many individuals of some species. A procedure is thus available for approximating the growth history of a population by study of a large sample taken over a short period. The validity of the use of plastral rings has been demonstrated in the slider turtle, *Pseudemys scripta troostii* (Cagle, 1946) and investigations in progress will evaluate their significance for estimating the growth of turtles of other species.

The rings of turtles taken from Lake Glendale, Illinois, in 1942, indicated growth greater than that observed in other Illinois turtle populations. Subsequent samples, totaling 260 individuals, provided ring measurements for growth analysis.

Area Investigated

Lake Glendale, near Dixon Springs, Illinois, is an artificial lake of 82 acres with a maximum depth of 25 feet exclusive of an old stream channel. The lake is 1 mile long, ¼ mile wide, and has 5.5 miles of shoreline edged with cat-tail. Prior to the flooding of the bed in 1940 the tributary streams were poisoned by biologists of the Illinois Natural History Survey to remove the fish. Bass and bluegills were introduced in April, 1940. The lake has been under observation of the Illinois Natural History Survey since 1939.

Methods

Mr. Donald Hanson, biologist of the Illinois Natural History Survey, provided a series of samples of turtles taken with hoop nets at irregular intervals during the period 1942–1946. Students from the Southern Illinois Normal University collected additional turtles in 1942 and 1943.

All turtles were measured and sexual maturity determined as previously described (Cagle, 1947).

The growth history of individuals was calculated from ring measurements. The rings on the abdominal plate were measured and the growth of each season calculated by the procedure described by Sergeev (1937) and verified for *Pseudemys* by myself (Cagle, 1946). Thus one individual collected in November, 1946, with a plastron length of 12.4 cm., had 4 rings measuring 13.7, 21.5, 24.3, 26.8 mm. in length respectively. The abdominal plate measured 29.1 mm. in length. Since the size of this plate is constant in relation to the plastron length we may calculate the growth for each season. This individual increased 33.2 mm. in length during the growing season of 1943, 12.0 mm. in 1944, 10.0 mm. in 1945 and 10.0 mm. in 1946. As the

[1] One of a series of reports resulting from researches supported by the University Council on Research, Tulane University.

calculated plastron length was 58.4 mm. at the beginning of the 1943 growing season the turtle was probably then entering its second season. It was thus 5 years of age when collected in November, 1946. This procedure has been used to determine the growth history of each turtle.

Population

The turtle population of the lake, as determined by samples taken by traps in 1942 and removed from hoop nets by Mr. Hanson, consists of approximately 62 per cent slider turtles, *Pseudemys scripta troostii,* 17 per cent snapping turtles, *Chelydra serpentina,* 12 per cent painted turtles, *Chrysemys picta* ssp., and 9 per cent musk turtles, *Sternotherus odoratus.* Both the mud turtle, *Kinosternon subrubrum subrubrum,* and the soft-shell turtle, *Amyda spinifera spinifera,* may occur in the lake but were not collected. The slider turtles only were considered in the growth study.

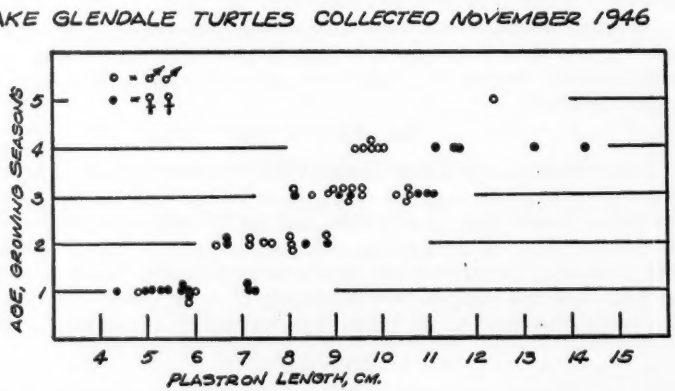

Fig. 1. The size distribution of *Pseudemys* collected from Lake Glendale, November, 1946.

A sample of 195 *Pseudemys* taken in November, 1946, consisted of 93 males and 102 females (Fig. 1). These were taken from hoop nets set in the only water remaining in the lake after it was drained in November, 1946. The males of the largest size group, 10–11 cm., were all sexually mature. Only one-third of those in the 9–10 cm. group were adult. Comparison with males from other areas indicate that these turtles exhibit no difference in the size at which they become mature. Some may reach maturity at a plastron length of 8 cm. but the great majority do not become mature until a plastron length of 10 cm. is attained (Cagle, 1947).

The males of this species become melanistic with age. Males were here classified as melanistic when the yellow lines of the carapace were obscured and the plastron was 75 per cent darkened. The smallest melanistic male measured 12.6 cm. in plastral length. All of the males larger than 17 cm. were melanistic.

The size distribution of the 102 females exhibits some clustering about the point at which sexual maturity is attained. Sexual maturity is normally reached at a plastral length of 15 cm. (Cagle, 1944), but females of this population did not reach maturity until attaining a plastron length greater than 16 cm., and one turtle 21 cm. in plastron length was a juvenile. Of the 102 females, only 26 were mature. None of the females were melanistic.

Age Determination

The determination of age is possible only in those individuals in which the ring formed at the border of the plastral scutes at birth is present or in which the growth for earlier seasons can be estimated. Growth is so variable during the first seasons (Cagle, 1946) that age estimates on the basis of size are rarely reliable. Only 59 individuals, 32 males, 27 females, could be aged.

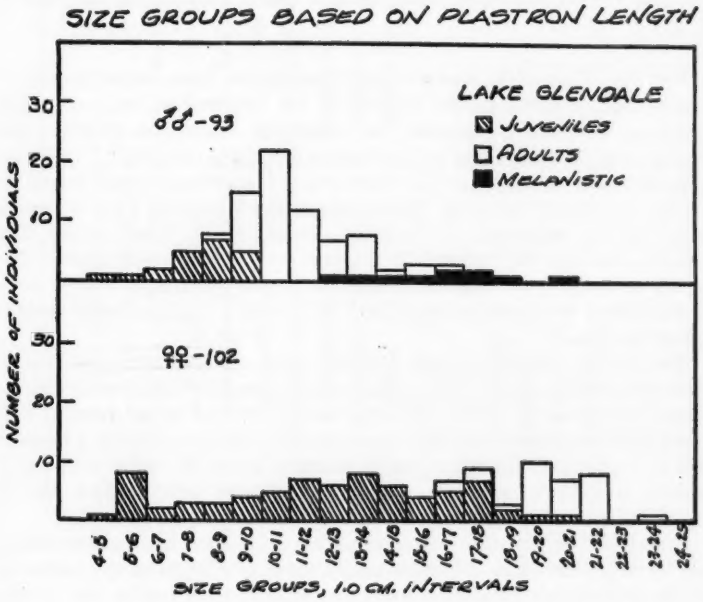

Fig. 2. The relation of age to plastron length.

Since all the individuals were collected during the period of inactivity between growing seasons, age may be expressed in terms of complete seasons (Fig. 2). A size overlap is evident in each of the first 3 age groups. The females of the 4 year group were all 8–32 mm. larger than the largest male. This is a reflection of the slowing of growth in males at attainment of maturity. All the males of this age group were sexually mature but all of the females were juveniles.

The overlap of age groups demonstrates the extensive variation in growth during the first seasons.

Reproductive Potential

The 26 mature females all contained multiple sets of ovarian follicles; 12 had groups greater than 5 mm. in diameter, 6 had 4 groups, 3 had 5 groups and 1 had 6 groups; 2 had only 2 groups. There was some correlation of number of follicle groups with size. None of the 4 individuals less than 18 cm. in plastron length had more than 3 groups. It is assumed that these groups represent successive clutches of eggs.

Each turtle 16–17 cm. in length had a total of 7–9 follicles greater than 5 mm., 17–18 cm., 9; 18–19, 22; 19–20, 6–14, av. 9; 20–21, 8–21, av. 16; 21–22, 9–20, av. 11. These counts reflect the variation in number of eggs per clutch and the increase of number of eggs per clutch with increase in size. The number of clutches deposited each season has not been determined.

Growth

Records of complete season's growth computed from measurements of growth rings permit a partial analysis of the influence of increasing size, attainment of maturity, seasons, and ecological factors on growth. The plastral length of *Pseudemys scripta troostii* hatchlings computed from measurements of the birth plate on 32 juveniles 2–6 years of age ranged from 2.28 to 3.32 cm., mean 2.71 $\pm$ .51. Individuals of this size group (Fig. 3) had a season's growth increment of 18–46 mm., mean 30 mm. These turtles thus averaged doubling their growth in the first season. This rapid growth decreased consistently in males with increase in size but remained high until the attainment of maturity (size group 10–11 cm.). Growth slowed rapidly beyond this point.

The females exhibit a similar but less rapid decrease in annual growth increments with increase in size. Size groupings arranged to provide a comparison with males are excessively small and do not reflect age groups. The annual increment line for females thus is irregular but does indicate a gradual slowing of growth to the size at which maturity is reached and a more rapid reduction of growth thereafter. The growth of large females (19+ cm. in length) is slow and often so minute that no growth is apparent.

Lake Glendale probably had a small fish population and comparatively large turtle population in 1941 since turtles were not effected by the poisoning and the original fish population had been replaced by a smaller one. Some effect on the growth rates of turtles might be anticipated.

The only available procedure for comparing the growth during different growing seasons is to calculate and compare growth of turtles of a given size or age group in different seasons. Unfortunately only 5 turtles were examined in 1941. The growth of these turtles was surprisingly rapid in contrast with growth of turtles from other water bodies. Thus one 2-year-old juvenile female had grown 78.4 mm. during its first year of life, the growing season of 1940. Its growth for the second season was similarly great (47.7 mm. per 100 days of growing season as compared with 51.2 mm. per 100 days for the first year of life). This growth exceeds by 36.3 mm. the maximum growth

previously observed in any other area for any season or in Lake Glendale in subsequent seasons.

Similarly, the 4 other turtles collected in 1941 exhibit exceptional growth for the two previous seasons. One large female, 17.2 cm. in length, had

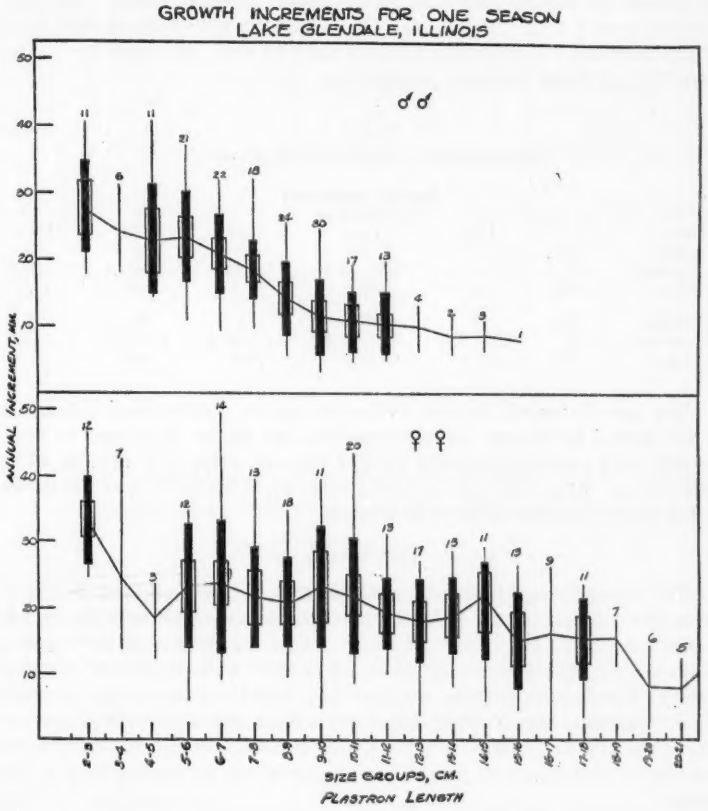

Fig. 3. Seasonal growth increments of Lake Glendale turtles. The single line indicates range; darkened rectangle one standard deviation on each side of the mean; light rectangle twice the standard error on each side of the mean. The graph line connects the means.

grown rapidly during 1940 and 1941 but had increased in plastral length only very slightly during previous years. This was clearly indicated by widely spaced growth rings enclosing light colored growth zones and a closely placed group of deeply etched rings near the inner margin of the earliest formed wide growth zone.

The growth of turtles during their first year should provide the best basis for comparison of growth in different seasons. Of 30 first season growth records from the years 1943–1946, the range was 13.5–46.4 mm., mean 28.7 mm.; mean first season growth for 2 individuals in 1943 was 33.8 mm.; 1944, 3 individuals, 39.2 mm.; 1945, 13 individuals, 23.8 mm.; 1946, 12 individuals, 30.5 mm. This first season growth averaged greater than that reported from 3 other Illinois areas. The maximum first season growth of all turtles examined in other Illinois waters was 42.1 mm., the means for 3 areas were 27.5, 18.7 and 8.75 mm. respectively.

TABLE I

THE GROWTH OF TURTLES IN FIVE SEASONS

		Growth Increments Millimeters				
Group		1942	1943	1944	1945	1946
Males (Juveniles) 0–10 cm.	No.	—	2	29	57	56
	R.	—	27.9–32.9	12.5–40.5	3.0–31.1	4.8–35.3
	M.	—	30.4	26.2	16.8	15.8
Females (Juveniles) 0.15 cm.	No.	3	16	33	56	58
	R.	27.4–39.4	12.9–43.6	11.3–46.4	6.1–34.7	5.1–45.0
	M.	33.9	38.7	34.6	18.7	21.5

The growth records for the 1942–1946 period further show differences in the annual increments for corresponding age classes from year to year. Juvenile males averaged growth of 30.4 mm. in 1943, 26.2 mm. in 1944, 16.8 mm. in 1945, 15.8 mm. in 1946 (Table I). Like differences are shown in the growth records of juvenile females.

DISCUSSION

The unusually rapid rate of growth in 1940 and 1941 and the decline in annual increments between 1941 and 1946 may be associated with the change in the fish population. The poisoning removed all the fish in 1939 and a relatively small population was introduced in 1940. This population increased rapidly. Mr Hanson informs me that bass and bluegills hatched in 1940 attained a larger size in their first 2 years than any 2-year-old fish taken since. He had observed no gross seasonal difference in fish growth for the five years, 1942–46. This growth picture resembles, in general, that of the turtles.

The rapid growth of turtles in 1940 and 1941 is probably a resultant of the lessened total population pressure, with reduced competition for food a major factor. The gradually decreasing annual rate of growth is to be expected if the size of the fish population was a significant factor in the growth of the turtles.

Under optimal conditions these turtles may grow very rapidly, males attaining sexual maturity in slightly more than one growing season, females reaching maturity in 3 seasons.

These data demonstrate that the juvenile turtle is capable of very rapid growth and that the growth rate is readily modified by an ecological change. It also appears that turtles in Illinois waters rarely encounter the best

growing conditions. As yet these "best growing conditions" have not been described for any reptile.

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The Food and Feeding Behavior of the Green Frog, *Rana clamitans* Latreille, in New York State

By W. J. HAMILTON, JR.

THE food of frogs has been studied by numerous investigators. Reports on the dietary habits of the genus *Rana* include Garnier (1883), Needham (1905), Dickerson (1906), Drake (1914), Shufeldt (1917), Munz (1920), Barbour (1920), Force (1925), Frost (1935), Carr (1940), Raney and Ingram (1941) and Kilby (1945). For a more detailed review of the literature, the reader is referred to Kilby (*op. cit.*), who has summarized the more important papers on the food of frogs and toads. In general, investigators concur in the observation that any animal small enough to be seized and swallowed provides food.

The green frog is a widespread species, of large size and some economic importance as food. It is, with *Rana pipiens*, the important contributor in New York State to the "frog leg dinner" seen on menus at summer hotels and roadstands. While it is generally recognized that a frog (or for that matter, practically any animal) will eat the food most readily available, specific studies provide precise information, not alone on the dietary, but on other habits of the species under discussion.

Circumstances, season and the whims of the collector determine in large measure the recorded data on the food habits of vertebrates. As an example, if the investigator collects green frogs on the borders of a pond during July, a reasonably large part of the food may quite likely consist of transforming

smaller frogs. If the collector is most industrious in the early fall of the northern states, the larger frogs he collects will contain caterpillars, notably those bent on a hibernation site, such as *Isia isabella*. Of 4 large *clamitans* collected within an afternoon hour on October 7, 1938, 3 contained such hairy caterpillars and the other, remnants of grasshoppers and crickets. Orthoptera play a conspicuous and prominent part of the dietary of all large frogs in the summer and early fall, as they do with numerous birds and mammals.

More than 500 specimens of *Rana clamitans* have been collected by the writer in New York State over the past twenty years. These have all been taken with precise data, the ultimate view being to present as complete a life history study as possible. Of those reported upon here, 4 were collected in March, 24 were taken in April, 31 in May, 102 in June, 138 in July, 119 in August, 88 in September, 14 in October and 6 in November.

TABLE I

STOMACH ANALYSES OF 434 GREEN FROGS OF VARIOUS SIZES (27 mm. to 97 mm.) COLLECTED FROM MAY-OCTOBER OVER SEVERAL YEARS IN NEW YORK STATE

Food	Percentage by bulk	Per cent frequency of occurrence
Coleoptera	22.1	41.9
Diptera	13.5	25.8
Orthoptera	12.8	13.4
Caterpillars	11.8	17.9
Hymenoptera	7.4	4.6
Arachnids	6.7	12.0
Cast Skin (*R. clamitans*)	3.9	4.6
Hemiptera	3.8	8.7
Amphibia (frogs)	3.3	3.7
Mollusks	3.1	4.6
Crustacea	2.1	2.8
Millipedes	1.5	3.2
Lepidoptera (adults)	1.4	2.8
Earthworms	.8	1.4
Fishes	.8	.9
Odonata	.5	1.6
Mecoptera	.5	1.4
Ephemeridae	.5	1.4
Centipedes	.4	1.4
Mites	.3	1.8
Undetermined insects	2.3	2.8
Total	99.8	

Collections were made in various parts of the state. One hundred ninety specimens were taken during July and August, 1946, at Long Lake; 60 specimens were secured at Rensselaerville, Albany County, from late June to early August, 1937 and 1938; 22 individuals were collected in Cattaraugus County in the summer of 1946; and 254 reported upon were taken during various months at Ithaca, New York, from 1928 to 1947. The frogs were killed immediately upon capture, measured shortly after killing and preserved in 10 per cent formaldehyde for later study. Specimens collect-

ed for food habits analyses range in size from newly transformed individuals to large specimens approaching 100 mm. in length.

Specimens were collected under variable conditions. Low temperatures, clear and cloudy periods, rainfall and other weather conditions were explored to determine what effect such might have on feeding behavior. The results merely indicate the adaptative behavior of the species. On July 16, 1946, the temperature dropped to 34° F. at Long Lake. Frogs taken early the following morning had fed during the cold spell. Those taken during mild spells in March and April had not fed, possibly because food items large enough to tempt them were not available. Collections made during prolonged rainy spells of midsummer show a preponderance of beetles with few dipterans in the stomachs. Either because such items are more abundant or more readily secured, the principal food consists of beetles, flies, grasshoppers and lepidopterous larvae. Combined, these constitute more than 60 per cent of the bulk eaten. Of lesser importance are hymenoptera, arachnids, the cast skin of the species, hemipterans, fishes, mollusks, crustaceans (principally crayfish), millipedes and adult Lepidoptera.

TABLE II

STOMACH ANALYSES OF 85 LARGE GREEN FROGS (60 mm.-97 mm.) COLLECTED FROM MAY-OCTOBER OVER SEVERAL YEARS IN NEW YORK STATE

Food	Percentage by bulk	Percent frequency of occurrence
Coleoptera	21.2	48.8
Caterpillars	17.4	32.9
Orthoptera	16.7	26.0
Amphibia	7.8	9.5
Hymenoptera	6.9	16.5
Diptera	4.3	9.5
Mollusks	4.1	8.2
Crustacea	3.4	14.1
Arachnids	2.7	10.6
Earthworms	2.1	7.0
Lepidoptera	1.8	3.5
Cast skin (*R. clamitans*)	1.4	8.2
Hemiptera	1.2	9.4
Millipedes	1.0	3.5
Centipedes	.7	4.7
Odonata	.4	1.2
Undetermined insects	6.5	16.5
Total	99.6	

Observations on individual frogs on numerous occasions for several hours at a time, to determine feeding behavior under natural conditions, were made necessarily in small pools or backwaters of streams, where it was possible to watch the individual for some time without alarming it. On August 21, 1946, at Ithaca, New York, I observed a large male *clamitans* from 3 P.M to 6 P.M. In that period it fed once and attempted to feed three times. The frog captured a large lycosid spider; eighty minutes later it stalked a damsel

fly. The attempt was unsuccessful. The frog immediately returned to its former position and in a few minutes again made an unsuccessful approach to a small dace, *Rhinichthys atratulus,* that had been stranded in the backwater. This again resulted in failure. Shortly before 6 P.M. the frog made a pass, which missed the mark, at a large carabid beetle. The beetle scurried off and was not pursued by the frog, although ultimate capture seemed likely.

Sight plays an important role in the capture of prey. I have watched a green frog, activated by the movements of a crayfish in a recently drained fishpond, stalk its prey from a distance of 12 yards, resulting in a successful capture. Either movement plays a large part in the food selected, or the green frog occasionally resorts to a vegetarian diet by choice. In May, 1936, when elm seeds were showering down on a quiet backwater and slowly drifting to faster water, I collected two large *clamitans* that had their stomachs largely distended with this item.

The green frog normally selects a stand and awaits its prey. When *Rana pipiens* or other small ranids are transforming, green frogs will select a position near the water's edge, appearing to move to points where the transforming individuals are emerging in greatest numbers. On July 7, 1947, I collected 4 large individuals in such a situation, all of which had captured transforming *pipiens.* Field observation and repeated collecting of green frogs in areas that abounded with transforming toads showed no evidence of their feeding on small bufonids although I have collected *Rana palustris* containing recently transformed toads at Long Lake and Ithaca, New York. Barbour (*op. cit.*) records *Rana capito* feeding on oak toads, *Bufo quercicus.*

This species eats its cast skin, contrary to the observations of Frost *(op. cit.)* who did not witness captive *clamitans* feed on its rejected skin. The observations of Kilby *(op. cit.)* suggest that *Rana pipiens sphenocephala* does not ingest its cast skin. Contrariwise, Knowlton (1944) found freshly cast frog skins in the stomachs of 6 of 91 Utah specimens of *Rana pipiens* examined. Analysis of ingested skins suggests it is discarded in a single piece, and that during the warmer months of the year, the molt is rather frequent. For example, of 53 frogs examined in July, 1946, 6 individuals (11.7 per cent) had eaten their cast skins. The observation suggests frequent casting of the skin during midsummer.

The green frog is active at all hours. It feeds as frequently at night as during the day. Kilby (*op. cit.*) likewise found *Rana pipiens* feeding at all hours. Collections and observations at night indicate aquatic species, principally crayfish and water insects, are selected during the dark hours more frequently than during the day, perhaps largely because these forms are more active at night. Collections made at midnight in various summer months of 1932 and 1946 reveal freshly ingested crayfish, odonate nymphs, young bullheads, and small ranids. The fish presumably are taken by day as well as at night. Late afternoon collections indicate such. Data are lacking by other investigators that the food of ranids is captured beneath the surface of the water. I have no direct evidence on this score, but the presence of small fishes, tadpoles and aquatic insect larvae presume the adaptability of this species, and strongly suggests that some of the food is captured beneath the water surface.

The repugnatorial glands of some hemipterans (notably pentatomids) have been credited with survival value; the skin glands of the pickerel frog *(Rana palustris)* presumably play a similar role (Dunn, 1935). It appears improbable that this factor is actually effective under natural conditions. Stink bugs of various species are frequently eaten by the green frog. A large *clamitans* collected at Long Lake on August 4, 1946, contained a recently transformed *Rana palustris*. Garter snakes also prey largely on *palustris* when these frogs are transforming.

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Flash Display of Aposematic Colors in *Farancia* and other Snakes

By D. Dwight Davis

THE sudden exhibition of bright colors that are ordinarily hidden from view is a widespread reaction of animals when annoyed or molested. The literature on this subject was recently reviewed by Cott (1940) as a subdivision of his chapter on "The Methods by which Conspicuousness is Attained" in animals. Cott considered snakes briefly in this connection, but knew only of certain snakes that rear up when molested, thus displaying conspicuously colored ventral plates. This is at best a questionable example of flash exhibition, especially when compared with the contorted postures, unequivocally associated with maximum display effect, assumed by other animals.

Unknown to Cott, Mertens (1931) had already given a much better review of this phenomenon in snakes. Mertens reviewed the known cases of snakes that, when disturbed or frightened, curl up the tail to display the underside. This habit had been observed in four unrelated genera of non-venomous snakes: *Oligodon, Cylindrophis, Doliophis,* and *Diadophis.* In each the underside of the tail is colored red. Of *Oligodon bitorquatus,* a small colubrid from the East Indies, Mertens relates that in addition to displaying the tail

> the anterior half of the body is also elevated with a sudden jerk, with the head drawn back by an S-shaped bending of this half, so that the ventral side (pale red in color) is also to be seen. Thus this is also doubtless a case of a frightening device, since the animals made no attempt to bite but were content to thrust at my hand a couple of times with the anterior part of the body.

A mud snake *(Farancia abacura)* recently received at Chicago Natural History Museum exhibited a remarkable flash display behavior that does not seem to have been observed heretofore, and which is more spectacular than any of the previously recorded instances. The snake was young, measuring only 298 mm., and was collected by J. E. Johnson, Jr., in Hardin County, Texas.

The mud snake is a burrowing, secretive form inhabiting the swampy lowlands of the south, where it burrows in the mud. The tail is short, tapers abruptly, and bears a spine at the tip. The color above is uniform black with no color pattern whatever. The belly and underside of the tail are red with contrasting black crossbands or checkers. The red of the belly is carried up onto the sides of the body for a short distance as triangular red markings. Thus *Farancia* is a good example of an animal that is conspicuously colored on parts that are normally concealed, and protectively colored elsewhere.

The specimen under discussion, when annoyed by poking or patting with the hand, persistently thrust its head under the coils of the body and elevated the tail, twisted into a tight coil, with the conspicuously colored underside uppermost (Fig. 1). If annoyed further the snake thrashed about convulsively, occasionally striking aimlessly with the head but not attempting to bite. Parts of the belly were often exhibited momentarily during this phase, but this appeared to be accidental. Additional molesting caused the snake

to turn over on its back, thus exhibiting the entire brilliantly colored underside (Fig. 2). The display was enhanced by spreading and flattening the

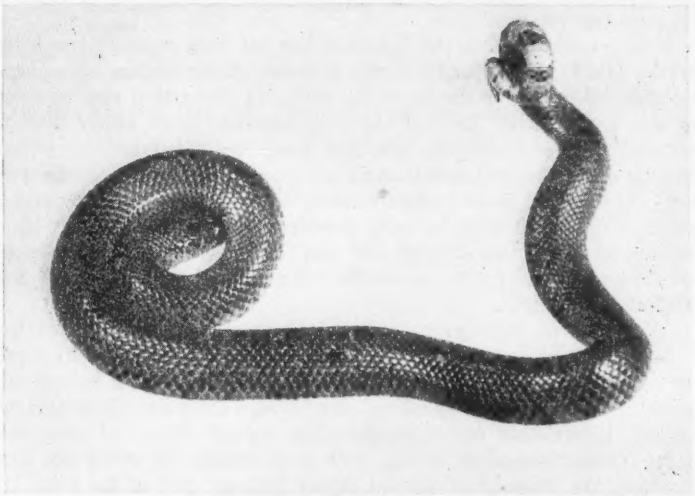

Fig. 1. Young *Farancia abacura* displaying the red underside of the tail following molestation. Note that the head is partly concealed beneath the coils.

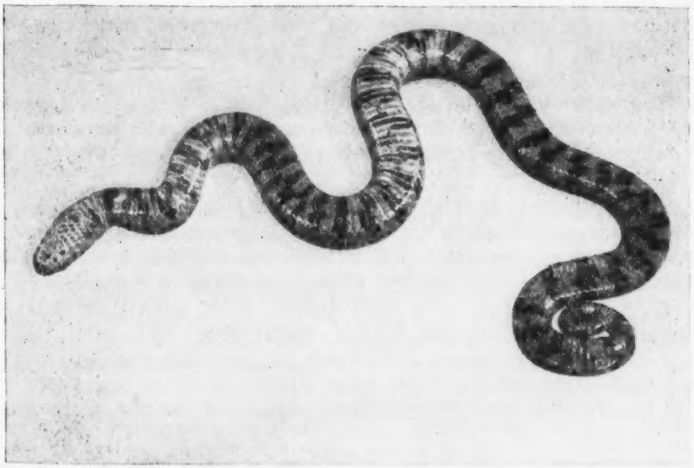

Fig. 2. The same snake lying belly up after further molestation. The posterior half of the belly is flattened, which increases the area of visible belly surface.

posterior half of the body, as may be seen in the figure. The animal would lie quietly in this position if undisturbed. During the final phase the body

was not limp, as it is in *Heterodon* under similar circumstances, and the snake did not promptly turn over on its back when righted as *Heterodon* does. This behavior was repeated on numerous occasions during the several days that the snake remained alive.

It is remarkable that this behavior has not been reported previously. Dabney (1919) stated that "*Farancia abacura,* when retreating from pursuit was observed to curl up the tip of the tail in a little vertical curl" and "the tail was conspicuously elevated and oscillated with much agility as if for defense." George P. Meade, who has undoubtedly handled more living *Farancia* of all sizes and ages than all other herpetologists combined, merely states (1946): "the smaller ones frequently show evidence of nervousness by probing with the tail spine, by rapid convulsive jerking of head, or by hiding the head in a tight ball of coils" and that the young "when handled would first show the bright pattern under the tail and then stab ineffectively with the diminutive spine."

Other types of warning display used by snakes, such as inflation of parts of the body (Noble, 1921) or flattening of the body as seen in *Heterodon* and some water snakes *(Natrix),* may incidentally enhance the normal color pattern or reveal the brightly colored skin between the scales. Such behavior, however, is obviously not directed mainly toward display of aposematic colors. Those blunt-tailed snakes, such as *Calamaria,* in which the form, coloration, and behavior of the tail closely "mimic" that of the head, also represent a quite different line of development.

Three features characterize flash display of aposematic colors in snakes. (1) The color displayed differs from colors appearing elsewhere on the body. (2) In every recorded instance the displayed color was *some shade of red.* (3) The snake assumes a posture that is never employed under any other circumstances. In *Farancia* the posture is so extreme that escape from a predator by flight is precluded.

The recorded instances also reveal that flash display is not restricted to secretive forms. Nor does it appear only in forms with a monochrome dorsal coloration; only *Diadophis* (except for the neck ring) and *Farancia* are so colored.

Perhaps the most astonishing feature of this behavior is the fact that its effect, if any, on a would-be aggressor is wholly unknown. Its effect on man is startling, to say the least. It is inconceivable that behavior so radically different from the normal behavior of the animal, and so obviously directed toward maximal display of specially colored areas, could have arisen on several separate occasions unless it has survival value. Nevertheless there is is no observational evidence to corroborate such an assumption.

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Herpetological Notes

HIBERNATION SITE OF THE LIZARDS *EUMECES* AND *ANOLIS* IN LOUISIANA.—On an inspection tour of Camp Livingston, Grant County, Louisiana, on Jan. 23, 1943, I had opportunity to visit much of the post. During typhus and malarial control operation details, the opportunity was presented for a few hours of collecting. The temperature at Dallas, Texas, on January 19 was 7° F. Press reports in northern Louisiana indicated similar severity of the cold spell. At Selman Field, near Monroe, Louisiana, low temperatures persisted on January 21, and residents remarked on the length of the unprecedented cold wave. Some moderation in the weather was evidenced on January 23, when the temperature rose slightly above the freezing point. Observations recorded were made at a temperature of 36° F.

Several interested soldiers accompanied me to search for armadillos, some of which had dug numerous holes in swampy areas and provided breeding sites for anophelenes. Incidental to this search, we pulled apart several rotted logs. In two logs, approximately 18-20 inches in diameter, hibernating lizards were uncovered. In one log, a group of 5 *Eumeces fasciatus* and 2 adult *Anolis carolinensis* were uncovered. In the second log, 3 *Eumeces fasciatus* and one adult and 2 immature *Anolis* (lengths 111 mm. and 89 mm.) were taken. In each group, the lizards were well within the log, frost in the damp wood almost reaching the hibernating animals. Individuals were almost touching one another; all had the snouts pointed in identical direction. The lizards were torpid and showed no activity after a minute of handling. Stomach analyses of the *Anolis* indicated no food other than fragmentary spider remains in one individual. One *Eumeces* contained a small beetle larva; stomachs of the others were empty.

In trickles and runs on the camp ground, I collected several *Manculus quadridigitatus*, an adult *Acris gryllus* and a recently transformed *Rana clamitans*. All were active and apparently were not affected by the cold wave. Stomachs of the cricket frog and green frog each contained remains of spiders.—W. J. HAMILTON, JR., *Cornell University, Ithaca, New York.*

VARIATION IN RING-NECKED SNAKES FROM SULLIVAN COUNTY, NEW YORK.—A collection of eleven specimens of ring-necked snakes (*Diadophis punctatus edwardsii*) was made in a roadside ravine at Forestine, Sullivan County, New York, all taken within a radius of 10 feet under flat rocks, along a stream. These specimens are in the collection of the American Museum of Natural History.

Sullivan County, New York, is adjacent to the northeast of Pike County, Pennsylvania and Pike County is north of Monroe County. The counties of Sullivan and Pike are separated by the Delaware River and the collecting areas lie approximately 36 miles apart.

Conant (1946, Bull. Chicago Acad. Sci., 7: 473–482) showed that there is a gradual decrease in the number of ventrals plus subcaudals from northern areas to southern ones, and likewise from upland to coastal plain. There is also an increase in ventral spotting from north to south and from upland to coastal plain. The neck ring likewise tends to become interrupted in the southern forms.

Tabulation of the eleven specimens shows agreement with the stated trend, showing a higher ventral plus subcaudal count, and a smaller number of spotted individuals.

TABLE I

COMPARISON OF VARIATION IN RING-NECKED SNAKES BETWEEN THE POCONO SERIES OF CONANT (1946) FROM MONROE AND PIKE COUNTIES, PENNSYLVANIA AND THE PRESENT SERIES FROM SULLIVAN COUNTY, NEW YORK

No. Spec.	Area	Ventrals and caudals Extremes	Mean	Ventral spotting Absent	Slight	Prominent	Neck ring Complete
11	Sullivan Co., N. Y.	208–228 (11*)	213	8 73%	1 9%	2 18%	11 100%
28	Pike and Monroe Co., Pa.	199–217 (22*)	209.4	17 61%	9 32%	2 7%	27 96%

* Number of specimens with complete tails for a complete count.

The extremes for the highest series of Conant were 199–217 ventrals plus subcaudals, for the Pocono Mountain collection of 22 specimens (Pike and Monroe County, Pennsylvania). The extremes of this Catskill Mountain collection (Sullivan County, New York) are 208–228, for 11 specimens. All specimens had complete neck rings and no chin or labial spotting.—HOWARD E. EVANS, *Zoology Department, Cornell University, Ithaca, New York.*

THE EGG-LAYING PROCESS IN THE TIGER SALAMANDER.—The egg-laying process was observed in detail in a series of tiger salamanders (*Ambystoma tigrinum nebulosum* Hallowell) recently transferred from a high altitude lake to a laboratory aquarium. Five female adults collected from Muskee Lake, located 15 miles west of Boulder, Colorado, at an altitude of 8300 ft., were observed to lay eggs over a two-hour period, immediately after transfer from their natural environment (59°F.) to the laboratory (70°F.) in Boulder (5300 ft.). The total length of time required for any one female to deposit all of her eggs was not determined.

The anal sphincter was contracted along the anterior-posterior axis in such a fashion that the mucous membranes of the cloaca were readily visible through the anus. These membranes were quite red and indicated considerable congestion of the smaller blood-vessels. The cloacal glands are always enlarged and the mucous membranes somewhat congested during the breeding season, and this congested condition was greatly increased by the irritation due to rubbing. The animals moved quite rapidly over the bottom of the aquarium and an effort was made to keep the anal region in contact with the coarse gravel bottom as much as possible. Pebbles of a diameter of .5 of a centimeter or more, twigs, and aquarium plants were selected as surfaces for deposition of the eggs.

The egg-laying was continuous except for short interruptions when the salamander

rose to the surface for air. The female was in constant motion over the bottom and paused only to deposit the eggs. Eggs were laid in any position that afforded contact of the anus to the surface upon which they were placed. Quite often the animal was suspended beneath the stem upon which the eggs were to be laid with the fore part of the body floating free and the posterior region tightly clasped to the stem. The eggs were deposited singly and the female gradually moved along the object as the eggs were laid. The largest number of eggs deposited in a single operation, that is, touching one another, were seven, although egg masses up to forty had been collected in the various lakes. The number of eggs per egg-mass in nature is extremely variable, with occasional single eggs.

When a small rock, twig, or other surface was selected for depositing the egg, the object was tightly clasped between the hind-limbs and the anus was rubbed vigorously in a lateral plane against the surface of the object. The tail was elevated in a vertical plane, and moved from side to side quite rapidly. At other times the tail moved rather slowly. The tail and body movements suddenly ceased and the animal remained quite motionless with its anal opening tightly pressed against the surface for from one to three seconds as the egg was laid.

The vigorous rubbing of the anus upon objects upon which eggs were deposited seemed to be a preliminary step necessary for the actual deposition of the egg. This rubbing movement appeared to act as a stimulus for the extrusion of the egg or eggs although rubbing frequently occurred without deposition of an egg.

During the egg-laying process the female's body was arched upward between the fore- and hind-limbs. The head was lowered somewhat, but the tail was noticeably elevated, sometimes as much as thirty degrees, and reached its greatest elevation at the end of the egg deposition. Muscular contractions that began about one centimeter anterior to the hind limbs and traveled posteriorly to the anal region along the body wall, were observed occasionally during the deposition of the egg. Other muscular contractions had their beginning immediately back of the fore-limbs and passed posteriorly to the region of the hind-limbs along the sides. The contractions arising in the region of the lower abdomen seemed to be for the purpose of passing the egg along the lower part of the oviduct, while those contractions arising in the more anterior region of the body might help in the movement of eggs within the body cavity and with their entrance into the ostium.

Male salamanders present in the aquarium paid no attention to the egg-laying although two non-laying females were observed eating eggs.

No eggs were laid by females kept in the laboratory longer than five days although many apparently gravid females were kept for several weeks.—ROBERT HAMILTON, *University of Colorado, Boulder, Colorado.*

THE LIZARD *AMPHISBAENA KRAUSSI* REDISCOVERED IN THE GOLD COAST.—Since *Amphisbaena kraussi* Peters, based on three cotypes in the Berlin Museum with only West Africa as type locality, was described in 1878, no additional material has been reported by any museum. Rediscovery of the species by Mr. G. S. Cansdale near the Banda Hills, about 40 miles northwest of Wendi, in northwest Ashanti, Gold Coast, furnishes us with the first definite locality, adds much to the meagre description accompanying Peter's figure, and reveals that the presence or absence of a frontal scute in these burrowing lizards is a character on which too much reliance should not be placed.

Amphisbaena kraussi was described as being characterized by the presence of a small frontal situated in the angle between a pair of large prefrontal and a pair of large postfrontals. This is true only of 8 of the 21 specimens collected by Cansdale in December, 1947; in the remaining 13 a frontal is lacking. Peters failed to give any counts of the annuli, which range from 211 to 222 on the body, 17 to 19 on the tail, with 28-30 (14-16 + 14) segments in a midbody annulus, which at first sight may appear to have only 12 + 12 owing to some being concealed in the lateral grooves; anals 6-7; preanal pores 8 in all. The largest example (MCZ 49701) now measures 139 (126 + 13.5) mm., but was 12 mm. longer when measured in the field by Cansdale.

The instability of head scale characters in amphisbaenids as evidenced by the presence or absence of a frontal in this series, merely confirms the opinion I expressed in my revision of the African Amphisbaenidae (1941, Bull. Mus. Comp. Zool., 87: 351-451) that genus *Chirindia* is an artificial one. Its revival by Laurent (1947, Revue Zool. Bot. Afr., 40: 54), together with the resurrection of *Cynisca* Gray for *kraussi*, appear to be without justification and rendered entirely impracticable by the numerous exceptions listed by Laurent (cf. pp. 54 and 55). This can most readily be seen by tabulating and contrasting the characters allegedly distinguishing the two "genera."

The absence of a frontal in some *kraussi* would cause these individuals to fall under sections II, A, 1, of my Synopsis (p. 375) and necessitate inserting *kraussi* between *liberiensis* and *bifrontalis*. I should like to take this opportunity of correcting a lapsus in my redescription of *A. kraussi* in which (p. 377, line 2) "behind the rostral," should read "behind the nasals."

Associated with *kraussi* in the same locality Cansdale found such choice things as *Amphisbaena leucura* Duméril & Bibron, *Acanthodactylus boueti* Chabanaud, *Leptotyphlops brevicauda* (Bocage), *Calamelaps u. unicolor* (Reinhardt), *Miodon g. gabonensis* (Duméril), *Rhamphiophis acutus togoensis* Matschie, *Tarbophis variegatus* (Reinhardt), besides many widespread forms.—ARTHUR LOVERIDGE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

POLYDACTYLISM IN AN ALLIGATOR.—During the course of studies on the alligator, *Alligator mississipiensis* Daudin, on the Sabine National Wildlife Refuge, Cameron Parish, Louisiana, a number of these reptiles have been captured, tagged and released for the purpose of obtaining mobility and growth data. One specimen measuring 33 inches in total length, taken on the night of June 12, 1947, exhibited a most unusual case of polydactylism, the feet being so much enlarged as a result of the additional toes that the oddness of the animal was immediately apparent.

Normally an alligator has 5 toes on the front feet and 4 on the hind feet. The abnormal individual had 3 surplus toes in front, making a total of 8 toes on each front foot, plus 4 extra toes on the left rear foot for a total of 8 and 3 extra on the right rear for a total of 7. These additional appendages were not useless, fleshy members as supernumerary digits often are, but were articulated, with some of them terminating in fully developed claws.

Without dissection it was impossible to make a final distinction between the normal and surplus digits. External resemblances were too close for complete differentiation. On each foot the middle pair of toes had failed to attain full size, though they were otherwise well developed. With this exception the toes appeared quite natural, even to the growth of connecting webs.

The front feet were similar in that they possessed 8 toes, the middle 4 toes of each foot bearing claws. In the natural condition only the inner 3 toes are clawed, so that we might assume in this case that the first 2 are extras, since they are without claws. The third toe appeared normal, while the fourth and fifth on each foot were crowded and shorter than usual. Their odd appearance may have been due simply to overcrowding. The sixth toe appeared normal and possessed a claw. The outer 2 toes were without claws, which is the usual condition.

The left rear foot bore 5 claws on the 8 toes, the 2 inner toes and the extreme outer toe being clawless. It appears likely that the outer group of 4 toes were the natural ones, for the alligator ordinarily has claws on the 3 inner toes of the rear foot, while the fourth toe lacks a claw. On this foot the 2 middle toes were also noticeably shorter than the others.

The right hind foot had one less toe than the other feet but had still another clawed toe, for a total of 6. The 2 short toes were in third and fourth position. These shortened toes could represent accessory members on either of the hind feet, for they are not necessary to fill the normal complement of toes with claws.

This animal was held in captivity for a short time for examination, after which it was tagged and released.—LEROY W. GILES, *Sabine National Wildlife Refuge, Louisiana.*

WINTER MORTALITY IN THE SNAKE *STORERIA DEKAYI*.—Too little is known about the hibernation habits of even our common reptiles. Observational data are so fragmentary that for most species the details of behavior, factors involved in site selection, and even thermal and exact temporal relations are unknown or imperfectly understood.

A hibernation den of *Storeria dekayi* (Holbrook) [1] was discovered quite by accident on March 22, 1939. Two freshly killed specimens were seen on U.S. Highway 61 near the Sugar Creek Bridge, about 5 miles north of Montrose, Lee County, Iowa. The roadway at this point is an elevated clay fill crossing the stream valley, and lies just above the confluence of the Sugar Creek flood plain with that of the Mississippi River. While searching the edge of the roadway embankment, Silas S. Sharp and I noted 2 or 3 live specimens of *dekayi* emerging from small burrows. A number of these passageways were excavated and found to contain numerous additional snakes. The ground was level, almost free of vegetation, and composed of mixed sand and clay. The tunnels were for the most part nearly parallel with the surface and formed a labyrinth of subterranean galleries. Noble and Clausen (1936, Ecol. Mon., 6: 261-316) have described and figured this diffuse type of hibernation aggregation, and have compared it with the single-cavity den. About a dozen active specimens were secured between the surface and 18 inches underground, and 20 dead individuals, including both juveniles and adults, were taken from the same passageways. No other species of snake was found. All of the dead snakes were within 10 inches of the surface. They were in various stages of decomposition, and obviously many had been dead for a considerable time. The mortality here was evidently due to winter kill during hibernation. In addition to the living specimens taken from the tunnels, more than a dozen were found on the surface nearby. Because of preceding cold weather, it is probable that the first emergence took place within the three days prior to our observations. The emerging snakes were fully exposed to bright sunlight (shade temperature at 11 A.M., 61° F.). The winter of 1938-39 was rather mild for the region, and unless local conditions were unusually adverse winter mortality such as that observed is probably not exceptional.

The role of hibernation as a factor in limiting the geographic distribution of reptiles seems to be unexplored, but it is well known that those species that live in regions of severe and protracted winters emerge from hibernation promptly on the advent of spring and retire late in the fall. Other species which are tardy in spring appearance and quick to seek winter seclusion not improbably find the brief remaining months of warm weather insufficient to carry on essential functions of existence, growth, and reproduction. Possibly the prolonged period of inactivity overtaxes the energy reserve. In either event the dispersal of such species into regions with a short growing season is prevented.

Barring the possibility that the winter is too long, hibernation should be a relatively safe period in a snake's life provided it descends to a protective depth. Whether or not snakes commonly fail to attain levels which provide immunity to winter kill is unknown. Failure such as is here recorded, if frequent, may play an important role in controlling snake populations. Furthermore, if certain species exhibit a marked proclivity to hibernate at shallow depths, the winter mortality in the northern part of the range might so reduce the population as to constitute a range-limiting factor.

The above remarks are speculative, but are offered to emphasize the need for detailed hibernation studies. Winter mortality does occur, but how commonly and under what circumstances? Is it of a magnitude such that population levels are significantly depressed?—REEVE M. BAILEY, *University of Michigan, Ann Arbor, Michigan.*

[1] The preserved series of 28 specimens of *Storeria dekayi* taken in and about this den site (Iowa State College, Number 574) was examined by Harold Trapido in the preparation of his revision of the genus *Storeria* (1944, Amer. Mid. Nat., 31: 1-84). Trapido listed this lot under *S. d. wrightorum* (p. 62), *S. d. texana* (p. 68), and as intergrades between these subspecies (p. 69). He apparently noted some specimens which agreed phenotypically with *wrightorum*, others showing characters of *texana*, and still others which were intermediate, and identified them accordingly (*op. cit.*: 82-83). There can be no reasonable doubt that this series represents a freely interbreeding population. Treatment of a series such as this as intergrades would better express the genetic composition of the population than to segregate phenotypes and apply subspecific designations.

STORERIA OCCIPITOMACULATA IN OKLAHOMA.—No record for the occurrence of *Storeria occipitomaculata* Storer in Oklahoma appears to be known. Trapido did not include Oklahoma in the range of this species in his paper on *Storeria* (1944, Amer. Midl. Nat., 31: 1-84) but the ranges indicated by him make eastern Oklahoma a logical area for its occurrence. Specimens of the subspecies *S. o. occipitomaculata* are now available from counties in eastern Oklahoma, one lying within the Ozark plateau, the other in the Ouachita Mountains. Three specimens are in the University of Oklahoma Museum, Division of Zoology, and one is in my personal collection.

The only adequate field data available are for a specimen collected by me in Mayes County, 5 miles north of Locust Grove, in northeastern Oklahoma, on March 16, 1945. This specimen was discovered about 10 A.M. at an air temperature of 74° F., as it was crawling over the pine needles and dead leaves carpeting the steep northeast slope of a limestone hill. A small stream runs through the valley at the base of the hill. The general vegetation is comprised of shortleaf pine, oak, and hickory trees. There is little underbrush but considerable grass. The entire hill is littered with small fragments of limestone, virtually no rocks more than a few inches in diameter being present. Since this description would fit much of the Oklahoma Ozark Plateau area it seems reasonable to suppose that *S. o. occipitomaculata* is little known here mainly because of the difficulty of collecting in such a terrain.

A single specimen from Latimer County is from 2½ miles north of Wilburton.

All of the specimens have 15 scale rows, all rows being keeled; the oculars 2-2 on each side, and the anterior temporal single. The lepidosis and measurements for the variable characters are tabulated below.

Mus. No.	Sex	Ventrals	Caudals	Upper Labials	Lower Labials	Post. Temp.	Total Length mm.	Tail Length
HAD 1190 Mayes County	♀	118	45	6–6	7–8	2–2	279	61
UOMZ 11186 Latimer County	♀	133	43	6–6	7–7	2–2	220	44
UOMZ 13972 Mayes County	♀	121	—	6–7	7–7	2–3	—	—
UOMZ 13973 Mayes County	?	119	—	6–6	7–7	2–3	—	—

— HAROLD A. DUNDEE, *Department of Zoological Sciences, University of Oklahoma, Norman, Oklahoma.*

OBSERVATIONS ON THE FEEDING HABITS OF THE SCARLET SNAKE.—In a pen about 20 feet in diameter a captive box turtle, *Terrapene bauri,* completed her nest at 7:50 P.M., April 1, 1945. I revisited the site at 9:30 P.M. and found a scarlet snake, *Cemophora coccinea,* with part of its body on the surface of the ground but with its head below, thrust inside one of the two eggs laid by the turtle. On April 17, 1945, another turtle of the same species was found resting over her just completed nest and, on removing the turtle, I again found a scarlet snake in the nest. This individual had already "sucked" two of the five eggs contained in the nest. About 8:30 P.M., May 3, 1947, I found another scarlet snake with its head in the cavity of a freshly dug nest that had been abandoned before the eggs were deposited, and just after dark on June 13, 1947, I caught one on the surface of the ground within the pen enclosure. On June 15, 1947, I removed the eggs from a nest that had just been completed, about dark. Later, at 9:00 P.M., I found a scarlet snake with its head in the now empty nest cavity. The next evening, June 16, at 8 o'clock, I found a turtle covering her freshly laid eggs with soil; and again I found a scarlet snake in the nest. It had eaten most of the contents of one egg which it promptly regurgitated when I picked it up.

On several occasions I have dug up turtle eggs the day after they were laid and

have found holes in them just large enough to admit the head of a scarlet snake, and with most or all of the contents of at least one egg gone. Apparently the contents of one egg exhaust the capacity of the average *Cemophora*, although I have found one which had eaten the complete contents of one egg and part of another. I have never seen the scarlet snake except at night during or shortly following deposition of turtle eggs.—JOHN D. DICKSON III, *RFD No. 4, Miami, Florida.*

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES—This list contains what records are available to us. There surely are better records as well as ten year records of other species and we would be very pleased to hear from anyone having such information. We intend to bring the list up to date each year as of the first of January.

Only the oldest snake of each species, or subspecies, is listed. An asterisk indicates that the specimen was alive on January 1, 1948. The snakes from the San Diego Zoo are the same as in last year's list (COPEIA, 1947, No. 2, June 30) brought up to date and new records added.

Species	Location	Years	Months
**Agkistrodon contortrix mokeson*	Brookfield Zoo	11	7
**Agkistrodon piscivorus*	R. M. Stabler	12	8
**Boa annulata*	Phila. Zoo	11	8
Boiga dendrophila	St. Louis Zoo	11	9
Constrictor constrictor constrictor	Phila. Zoo	12	3
**Constrictor constrictor imperator*	S. D. Zoo	10	3
Crotalus adamanteus	No. Carolina St. Mus.	15	0
**Crotalus atrox*	S. D. Zoo	11	7
Crotalus horridus horridus	Syracuse Univ.	13	0
**Crotalus ruber*	S. D. Zoo	10	5
**Crotalus tortugensis*	S. D. Zoo	10	9
**Crotalus viridis oreganus*	S. D. Zoo	10	10
Drymarchon corais couperi	Grace Wiley	11	11
**Elaphe guttata*	Phila. Zoo	18	4
**Elaphe quadrivittata quadrivittata*	S. D. Zoo	10	7
Epicrates angulifer	Washington Zoo	11	9
**Epicrates cenchria crassus*	Staten Island Zoo	10	2
Epicrates cenchria maurus	Bronx Zoo	27	4
Epicrates striatus	Phila. Zoo	16	0
Eunectes barbouri	Phila. Zoo	13	11
Eunectes deschauenseei	Phila. Zoo	13	10
Eunectes murina	Washington Zoo	28	0
Helicops schistosus	Phila. Zoo	12	3
**Lampropeltis getulus californiae*	S. D. Zoo	11	1
Lampropeltis getulus brooksi	S. D. Zoo	10	0
**Lichanura roseofusca roseofusca*	S. D. Zoo	11	6
**Masticophis flagellum testaceus*	S. D. Zoo	11	2
**Naja melanoleuca*	S. D. Zoo	19	3
Naja naja naja	Phila. Zoo	12	4
Naja naja atra	Brookfield Zoo	10	3
**Naja nigricollis*	Brookfield Zoo	13	2
**Naja nivea*	S. D. Zoo	10	11
**Ophiophagus hannah*	Grace Wiley	10	3
**Pituophus catenifer annectens*	S. D. Zoo	11	4
**Python curtus curtus*	St. Louis Zoo	14	7
**Python molurus bivittatus*	Phila. Zoo	12	6
**Python molurus molurus*	Phila. Zoo	13	0
Python reticulatus	St. Louis Zoo	20	0
**Python sebae*	Phila. Zoo	11	1
Sistrurus catenatus	Tabor College	14	0
Ungaliophis guatemalensis	Grace Wiley	17	8

C. B. PERKINS, *Zoological Society of San Diego, San Diego, California.*

THE STATUS OF THE SALAMANDER *DESMOGNATHUS QUADRAMACULATUS AMPHILEUCUS*.—In 1941 Bishop described *Desmognathus quadramaculatus amphileucus* on the basis of 3 specimens from Demorest, Habersham County, Georgia (Occ. Pap. Mus. Zool., Univ. Mich., 451: 12). The coloration of this salamander was unusual in that the snout, tip of tail, and limbs were whitish, while the remainder of the animal was black. When I read the description, it struck no chord of memory although I had collected extensively in northeastern Georgia. Upon examining my collection, however, I found many examples agreeing with *amphileucus* in coloration. A series of such specimens from Tiger, Rabun County, Georgia, was described as *D. q. quadramaculatus*, since they exceeded the supposed maximum size of *amphileucus* and the pattern of the latter was not developed in the larger examples.

During the summer of 1947, Mr. Robert L. Humphries and I collected in northern Georgia and adjacent areas. We found no *D. quadramaculatus* in the immediate vicinity of Demorest, but took a few specimens not far to the north, near the Habersham-Rabun County line. In life these salamanders were scarcely distinguishable in coloration from typical *quadramaculatus*, except that the snout was tan. After three days in preservative, however, the snout, tip of tail, and limbs had become whitish with vague mottlings. The smaller specimens, at least, might have been called *amphileucus*. Just above the North Carolina-Georgia border, on U. S. Highway No. 23, we took *D. quadramaculatus* that changed but very little in preservative.

Later in the summer I revisited the Tiger locality, collecting a series of the form at the same spot where it had been taken several years before. All displayed brownish legs, tan snout, and horn-colored tail tip. After a few days in preservative these areas became very light, almost white in the smaller examples. These specimens, and the original Tiger specimens, now mostly resemble *amphileucus* in coloration.

I am not sufficiently familiar with typical *quadramaculatus* to say whether it too might develop comparable light areas after some time in preservative. Probably it does; Cope notes that, in 20 specimens of *"D. nigra"* examined by him, the coloration was black above and below, except the muzzle from between the eyes, the lower jaw, the end of the tail, and the soles of the feet, all of which were brown (1889, Batrachia of North America: 199).

I do not believe that the *amphileucus* pattern is present to any noticeable degree in living specimens. It is certainly not developed throughout most of the range of the form as mapped by Bishop (1943, Handbook of Salamanders: 211). Wood mentions collecting several specimens 3 miles west of Demorest, but unfortunately he does not describe their appearance in life (1947, COPEIA, 1947: 273).

Netting states that he is dubious of the validity of *D. q. amphileucus*, "at least as it is now defined" (1945, Ecology, 26: 105). It seems to me that the southern specimens can be distinguished from the more northern ones by certain characters cited by Bishop. Thus, of all the specimens collected between the type locality and the North Carolina border, the largest, taken 18 miles north of Demorest, measures 146 mm. in total length. This is considerably less than the maximum for typical *quadramaculatus*. In all but the largest specimens from this region, the eye is very prominent, its horizontal diameter being contained about 1.2 times in the length of the snout. In most of the specimens there are less than 2 intercostal spaces between the appressed limbs.

On the basis of material in my collection, *D. q. amphileucus* seems valid, but should be redefined as follows: Size rarely, if ever, exceeding 150 mm. total length, and usually much less; one to two intercostal spaces between the appressed limbs; eye large and prominent, its horizontal diameter contained less than 1.5 times in snout length, about 1.2 times in the average adult. Snout, tip of tail, and sometimes limbs slightly lighter than the remainder of the body, particularly in small examples; these areas often becoming much lighter in preservatives. Range, the southern Appalachians from about the North Carolina-Georgia border southward through Habersham County, Georgia.—WILFRED T. NEILL, *Dept. of Biology, Augusta Junior College, Augusta, Georgia.*

FOOD HABITS OF TRITURUS GRANULOSUS IN WESTERN OREGON.—Collections of *Triturus granulosus granulosus* (Skilton) were made during the months of April, May, and June, 1947, at five localities in western Oregon. Collections were taken only from trout waters. These localities were:

A tributary to Boulder Creek, which is a tributary of the lower Rogue River, south of Iron Mountain, Curry County. It is a slow, clear stream flowing through a meadow at 3500' elevation. Twenty-two specimens were collected at 5 P.M. on April 26, 1947.

Strawberry Flats, on the west side of the Rogue River, 3 miles above Agness, Curry County. Eleven specimens were taken from small and large pools and eddies of the main river, at 8:30 A.M. on April 27, 1947.

Arboretum Lake, situated in McDonald Forest in the Willamette Valley, 10 miles north of Corvallis, Benton County. This is an artificial lake in which trout production studies have been carried on for several years. Eight specimens were collected at 3:30 P.M. on May 20, 1947.

South Santiam River at Foster Bridge, Linn County. Thirty-five specimens were collected at 7:30 A.M. on May 24, 1947, in eddies and pools through which river currents were flowing.

Nash Lake, on the headwaters of the Yaquina River, 3 miles north of Nashville in Lincoln County. It was created by a landslide, and is also fed by a spring. Twenty-eight specimens were collected at 2 P.M., June 3, 1947.

A summary of food materials found in individual stomachs follows. The data are based on the number of individual organisms present in each specimen, because it was difficult to get accurate relative proportions of the various food items present, either by weight or by volume.

TABLE I

FOOD SPECIES OCCURRENCE IN ANIMALS TAKEN AT EACH LOCALITY

Locality	No. of Stomachs examined	No. of diff. food species	No. Species taken/individual	No. Items/ individual
Boulder Creek	22	19	1-3	1-10
Strawberry Flats	11	17	1-5	2-58
Arboretum Lake	8	11	0-4	0-14
South Santiam	35	25	0-8	0-19
Nash Lake	28	13	0-5	0-72
Total in all localities:	104	50		

TABLE II

FOOD SELECTIONS BY LOCALITIES

Item Abundance is based upon the number of occurrences in specimens of each locality.
Frequency % is based on ratio of occurrence in individuals to the total number of individuals taken at any one locality. There may be more than one item with the same frequency per cent. "Plant matter" is all unidentified.

Rating	Boulder Creek	Strawberry Flats	Arboretum Lake	South Santiam	Nash Lake
Item Abundance					
First	Baetidae	Baetidae	Corixidae	*Goniobasis* (snail)	Chaoboridae
Second	*Triturus* eggs	Hydropsychidae	Coenagrionidae	*Rana boylii* eggs	Cladocera
Third	Plant matter	Heptageniidae	Baetidae	*Physa* (snail)	Chironomidae
Fourth	Diptera	*Hyla* eggs	Cladocera	*Triturus* eggs	Baetidae
Fifth	Algae	Chironomidae	Chironomidae	Heptageniidae	Algae
		Plant matter	Limnophilidae		
Frequency %					
First	Baetidae	Baetidae	Coenagrionidae	*Goniobasis*	Chaoboridae
	Triturus eggs			*Rana boylii* eggs	
%	36.0	91.0	50.0	37.1	85.7
Second	Plant matter	Hydropsychidae	Corixidae	*Physa* (snail)	Chironomidae
%	27.0	45.0	37.5	31.4	39.3
Third	Algae	Heptageniidae	Baetidae	Heptageniidae	Baetidae
		Plant matter	Limnophilidae		Algae
%	18.0	27.0	25.0	22.6	35.5

SUMMARY.—One hundred and four specimens from five localities produced a total of 50 different food items. Specimens from the S. Santiam River contained the largest variety of food items—25 different foods, possibly because the most individuals were collected there. The number of food items found in any one stomach varied from 0 to 72. The average for the 104 specimens was 9.42. The number of different items found in any one stomach varied from 0 to 8. The average number of different items taken per individual in all localities was 10.3. Animal food was taken about 88 per cent of the time, Insecta being the predominant class. Mayflies are the most important food item.

There is definitely a strong competition with trout for the trout's preferred foods, since Baetidae have frequencies of 91.0, 36.0, 35.5, and 25.0 per cent, Chaoboridae 85.7 per cent, and Coenagrionidae 50 per cent. Hydropsychidae have a frequency of 45.0 per cent in the present study. All of these insect families rank high on the food preference list of trout, for according to food habit studies of rainbow trout by Needham (1940, Trout Streams, Comstock: 122) mayflies, caddisflies, and Diptera are the predominant foods eaten.

Findings on *Triturus* food habits are in general agreement with those of Asa Chandler (1918, Oregon Agric. Coll. Exper. Sta. Bull., 152: 1-24) and Donald S. Farner (COPEIA, 1947: 259-261).—FRED G. EVENDEN, JR., *Oregon State College, Corvallis, Oregon.*

MUHLENBERG'S TURTLE IN SOUTHERN NEW YORK.—Returning from a field trip in the Montrose District of the Town of Cortlandt, Westchester County, New York, during the late afternoon, June 21, 1947, my associate, Thomas M. Heaphy, discovered the mutilated remains of a female Muhlenberg's turtle, *Clemmys muhlenbergii* (Schoepff), in the middle of the road.

On June 28, on return to the site, I found a small flooded meadow on the north side of the road; at the rear of the meadow, in a section of woods, was a small pond approximately a foot in depth. Sphagnum moss was fairly abundant at the pond and in the swampy meadow.

The second specimen of *C. muhlenbergii* found was an adult male taken in the meadow. Its carapace was only partly covered by water. Less than 4 yards away I found an adult female. The two temporal blotches on the head of the female were decidedly yellowish while those of the male were orange. The carapace of the male measured 85 mm. (3.34 inches), and that of the female 87.3 mm. (3.44 inches).

On July 5, 1947, I collected another female specimen of *muhlenbergii* (89 mm.) in the meadow, and a considerably younger individual, measuring only 75 mm., was collected on July 26.

Spotted turtles, *Clemmys guttata* (Schneider), were encountered on every field trip to this area.

Regarding the more southerly range of *C. muhlenbergii* in New York state, Miss Adeline Thurston, science teacher at the Nathaniel Hawthorne School, Yonkers, informs me that a former pupil caught a specimen several years ago at White's Pond in north Yonkers, lower Westchester County.—HAROLD R. ASHLEY, *50 Saratoga Ave., Yonkers 5, New York.*

Ichthyological Notes

A NEW NAME FOR *PARALEPIS DANAE*, A SPECIES OF FISH FROM NEAR CAPE VERDE, AFRICA.—In 1933 (Vidensk. Medd. fra Dansk naturh. Foren., 94: 223-224) Ege described a new species of the family Sudidae under the name *Paralepis danae*. Although not mentioned, presumably this species was named in honor of the research vessel "Dana" of the Carlsberg Foundation. Unfortunately this name is preoccupied according to the International Rules of Zoological Nomenclature, article 35 (a specific name is to be rejected as a homonym when it has previously been used for some other species or subspecies of the same genus). A subspecies of the same name was described for *Paralepis pseudosphyraenoides* by Ege (1930, Dan. Ocean, Exped. 1908-10, 2 (13): 79-81, fig. 19) from material taken across the Atlantic in a narrow belt from off North Carolina to the north coast of Africa. *Paralepis* as defined by Ege (1930, *ibid.*, 2(13): 1-201, figs. 1-37; 1933, Vidensk. Medd. fra Dansk, naturh, Foren. 94: 223-236), Parr (1931, COPEIA (4): 152-158) and Maul (1945, Bol. Mus. Mun. Funchal. 1(1): 1-38, figs. 1-10, tables 1-17) still contains both the subspecies *danae* Ege, 1930, of *Paralepis pseudosphyraenoides* and the species *danae* Ege, 1933.

As I could find no evidence that a new name had been previously proposed for either "*danae*," the matter was referred to Dr. Ege. He was of the same opinion and urged that a note be prepared changing the name of *Paralepis danae*, 1933. The latter, more recent species is here renamed *Paralepis* ***egei*** in appreciation of Dr. Ege's contributions to our knowledge of the bionomics and classification of the family Sudidae. This species is still known only from an adolescent specimen 38 mm. in total length, taken off the western coast of Africa, near Cape Verde (13° 31′ N., 18° 03′ W.), 3000 meters of wire out. The usual range of variation for the pectoral rays is 10-13 for this genus. *Paralepis egei*, new species, has 17 pectoral rays, apparently differing in this respect from all other Atlantic species of this genus except *Paralepis brevis* Zugmayer. Probably the only species with a higher count is *Paralepis squamosus* (Chapman) from the North Pacific, which has 20 pectoral rays.—ROBERT R. HARRY, *Natural History Museum, Stanford University, California.*

THE DISTRIBUTION OF THE PIPEFISH *DORYICHTHYS BREVIDORSALIS* (DE BEAUFORT) IN THE EAST INDIES.—The rare *Doryichthys brevidorsalis* has been reported in the literature from near Kajeli, Buru (Boeroe), by de Beaufort (1913, Bijd. tot de Dierkunde: 93-164), from south New Guinea by Duncker (1915, Mitt. naturh. Mus. Hamburg, 32(2): 9-120), from the same localities by Weber and de Beaufort (1922, Fishes of the Indo-Australian Archipelago. IV. Leiden: i-xiii, 1-410) and from the Malay Peninsula by Herre (1937, Bull. Raffles Mus., Singapore, 13: 5-60). Since the Malay examples are described as remarkably divergent from the other specimens and represent a range extension of over 1500 miles for this species, they have been re-examined in order to determine whether they represent a distinct form.

These two specimens, 61 and 70.5 mm. in standard length (Stanford University no. 30915; collected 60 miles north of Singapore, Mawai District, Johore, Malay Peninsula, March 22, 1934), recorded by Herre, appear to be quite different from *Doryichthys brevidorsalis*. The dorsal has 31 and 32 rays (not 28 as stated by Herre) instead of 24 as in *Doryichthys brevidorsalis*, there are 33 and 35 tail rings as compared to 28 in the latter, the inferior cristae of the trunk are continuous versus discontinuous, and the inflated operculum has a single median longitudinal keel instead of two or three strong keels.

Redetermination reveals that Herre's material does not differ from *Doryichthys martensii* (Peters) which is very common in the streams of Mawai District, Johore, and these two specimens are now assigned to this species. As no other example of *Doryichthys brevidorsalis* has been recorded from the Malay Peninsula, it seems advisable to restrict the known range of this species to Buru (Boeroe) and south New Guinea.—ROBERT R. HARRY, *Natural History Museum, Stanford University, California.*

WHALE SHARKS AND DEVIL RAYS IN NORTH BORNEO.—On the 11th of August, 1947, while crossing Darvel Bay, British North Borneo, position approximately 5° 44′ North Latitude, 118° 30′ East Longitude, accompanied by Major C. W. Simmons, Assistant Custodian of Enemy Property, a mixed flock of seabirds including brown boobies, frigate birds, terns and shearwaters was observed working over what appeared to be a large shoal of fish. As the launch, a forty-foot army workboat, approached the shoal, large dark fins were seen projecting from the water. The launch entered the area occupied by the shoal at about 3:30 P.M. The sea was flat calm with occasional "cats paws," the sky less than one-fourth overcast, and visibility excellent to at least 4 fathoms.

The first fish clearly seen were tuna, two small shoals, with the fish leaping freely. Two specimens of approximately 8 pounds caught later by troll lines were tentatively identified as *Euthynnus macroptera*. Close to the tuna shoal—in fact the whole aggregation of fish and birds appeared to be confined to an area of less than 200 acres—the large projecting fins were clearly in evidence. The launch cruised at low speed and, from the cabin top, it was seen that two distinct types of fins were present. The smaller and more numerous were readily identified as the pointed tips of the lateral flaps of large devil rays (*? Manta* sp.). As far as can be determined, about 30 to 40 of these rays were present, and they varied in "spread" from about 6 to 10 feet. The rays were slowly cruising about close to the surface, the "wing" tips often projecting and, frequently, the shallow dome of the head and nape appearing above water level.

They betrayed little or no interest in the launch, and allowed us to approach within a few feet before "shearing off." Below the surface, the rays frequently rolled over, swimming on their backs, the silvery white under-surface, wide gill clefts and blunt pre-ocular horns showing distinctly through the clear water.

The rays formed in fairly well defined but dispersed shoals within which other species were rarely seen. Close to and occasionally mingling with the edges of a shoal of rays were two small shoals of the gigantic whale shark (*Rhincodon typus* Smith). These enormous creatures, with their bluff snouts, and dark brownish skin liberally spotted with silver, were even less affected by the presence of the launch than were the rays. The smaller shoal, about 9 sharks, contained also the largest. The great fish surfaced within 6 feet of the side of the launch and it was estimated to be about 35 feet in length. The smallest whale shark noted, and there appeared to be from 20 to 25 in the two shoals, probably did not exceed 15 feet in length. Like the rays, the sharks generally remained very close to the surface, often with the dorsal fin and upper fluke of the tail projecting, and cruised slowly about. Frequently they surfaced with the body inclined at an angle of about 15° to the surface, the largest square snout projecting 3 to 4 inches above the water. Cruising in this manner, they reminded one irresistibly of small LCP's (military landing craft) under weigh.

The whale sharks also were fairly widely dispersed, and associated with each one was a shoal of up to a few hundred small (*ca.* 6 inches long) yellowish-silver stromateid fish (sp. ?, possibly young *Stromateus cinereus*). These fish swim almost invariably on their sides, suggesting pleuronectids, and although somewhat scattered, each shoal closely followed the movements of its gigantic companion. The stromateids appeared generally to travel about 1 fathom below the whale sharks.

In an attempt to secure a specimen for close examination, three of the rhincodons were killed by a .303 rifle fire but on each occasion the shark sank before a rope could be fastened to it. As the dead sharks rolled over in sinking, it was noted that each carried a number of remoras (Echeneidae). On one occasion, immediately after the dead shark had sunk, the accompanying shoal of stromateids transferred its allegiance to the launch and remained in attendance until speed was increased. It is probable that this remarkable aggregation of fish was feeding on some form of plankton, although no macroplankton was seen from the launch.—J. A. Tubb, *Fisheries Survey Officer, Sandakan, Colony of North Borneo.*

A PREOPERCULAR TAG FOR PERCH.—The jaw tag method of marking fish (Shetter, 1935, Mich. Acad. Sci., Arts and Letters, 21: 651-653) can be modified in various ways to account for anatomical differences in the species marked. As originally described, the tag fits around the maxillary bone. This method is particularly suitable

for centrarchids but fails to give satisfactory results for fish with more delicate mouth-parts. In 1946 and 1947 a method for attaching a tag to the preopercular bone of perch (*Perca flavescens* Mitchill) was developed at this Laboratory and used for tagging 1300 fish in Lake Mendota.[1] Previously, various positions of affixing the tag had been tried and discarded, the maxillary bone among them.

The tags employed were made of monel metal, 9 mm. long and 2 mm. wide, for fish up to 20 cm.; slightly larger tags were used for larger specimens.

The tag is opened to almost a right angle and grasped between thumb and forefinger at its straight part. The tongue of the locking mechanism is slipped under the preopercular bone where this shows greatest curvature and the tag is tilted so that the tongue pierces the skin above the bone. The tongue can then be grasped with the pliers and the tag is pulled into the correct position around the bone (Fig. 1). The tag is closed by pressure of the fingers; locking proceeds in one motion where the short and long ends of the locking mechanism are bent simultaneously.

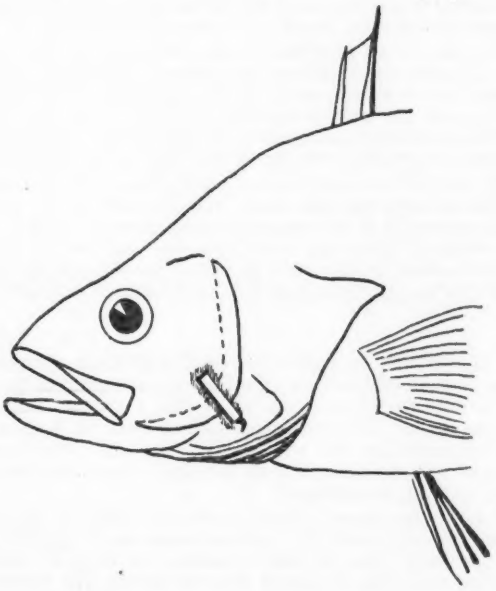

Fig. 1. Position of tag on the preopercle of the yellow perch.

One hundred fish can be tagged in one hour; one man tagging, one recording. It should be mentioned, however, that only tags of similar resilience to monel metal lend themselves to this operation, since the tag is employed to pierce the skin. For tags of softer material a small hole can be pierced with an awl before inserting the tag under the preopercular bone.

The method here described seems to have some advantages for perch and fish with similar cranial bone structure, since:

1) The tag is subject to very little movement; the preopercular bone is firmly connected with the opercle and moves together with the gill flap, thus offering no serious hindrance to respiratory efficiency.

[1] Supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation and also in part by the Wisconsin Conservation Department.

2) Feeding is not impaired; the very delicate membrane around the maxillary and premaxillary bones remains intact.

Tank and field trials proved satisfactory in that the infection rate was low. Tags on confined fish remained firmly in position for a trial period of two months; on recaptures from Lake Mendota for four months.—JOHN E. BARDACH and E. DAVID LE CREN, *Department of Zoology, University of Wisconsin, Madison, Wisconsin.*

A POSSIBLE FUNCTION OF THE UROSTYLE IN IMMATURE *UMBRA PYGMAEA*.—While observing in confinement a small group of immature mud-minnows, *Umbra pygmaea* (De Kay), taken at Alley Pond State Park, Hollis, Long Island, May 29, 1948, ranging from 15 mm. to 22 mm. in total length (including caudal), I noticed what appears to be a function of the projecting urostyle (described for young *Umbra* by Breder, 1933, Amer. Mus. Novit., 610: 1-5).

It appeared that, whenever one of the fish was about to begin moving from a stand-still, a fraction of a second before the fish moved, the urostyle, which was conspicuously almost black in color, would begin vibrating independently of the caudal fin.

It was noticed that, in the pond, these young fish stayed in rather well spread-out schools of ten or twelve, which scattered when alarmed. Therefore it would seem that, just as the dark mark at the base of the caudal, immediately below the urostyle, may be a recognition mark, this vibration may act as a signal to the other members of the school that the fish is about to move, possibly because of approaching danger. If this is so this movement is homologous with that of the "flag" of the white-tailed deer.

Breder (*loc. cit*) points out that the urostyle in young *Umbra* is absorbed into the caudal fin's structure as the fish grow larger. This is corroborated by the fact that the urostyle is most pronounced in the smallest (15 mm.) specimen collected. This fact also helps to substantiate the theory that is put forth here, as, when the fish grow larger, they become more solitary in their habits and do not travel in schools. Therefore there would be no further need of the urostyle as a signal.—MALCOLM S. GORDON, *1305 53rd St., Brooklyn 19, N.Y.*

PACIFIC MACKEREL IN THE GULF OF CALIFORNIA.—Published reports of the distribution of the Pacific mackerel (*Pneumatophorus diego*) give its range as from Alaska south to Cape San Lucas at the tip of Baja California. However, on three trips made by the Division of Fish and Game research vessel "N. B. Scofield," mackerel were collected well within the Gulf of California. They were taken in sufficient numbers to demonstrate that the species is fairly abundant, at least along the southern portion of the east coast of the peninsula.

Collection stations are shown in Figure 1. The first catch was made on the night of May 19, 1939, in Agua Verde Bay. A large school was attracted by a light hung over the side, and Ralph Dale, the vessel's engineer, and the writer caught about 10 specimens on hand lines. The fish stayed deep and showed little interest in cut bait. The following day we caught a single specimen on a jig while trolling for tuna about 13 miles east of Agua Verde. Circling the area, a school of mackerel-sized fish was observed but none was taken.

D. H. Fry, Jr. and J. F. Janssen, Jr. collected 17 specimens at Espiritu Santo Island on February 2, 1940, and 61 at Mangles Anchorage on February 5.

J. G. Carlisle, Jr. and the writer found mackerel very abundant at Espiritu Santo and Ceralbo Islands from the 18th through the 20th of February, 1941. Samples of several hundred fish were obtained, including a few individuals from 35 to 55 mm. in length. Most of the adults were in spawning condition, as were those collected the year before. Almost all of the fish were caught on poles with baited hooks. Fishing with feathered hooks was not particularly successful, while the commercial method of "scooping" was not effective. The water was full of live feed, and the mackerel paid scant attention to the ground bait used as chum. Water temperatures were between 21° and 22°C. at both islands.—PHIL M. ROEDEL, *California Division of Fish and Game Bureau of Marine Fisheries, Terminal Island, California.*

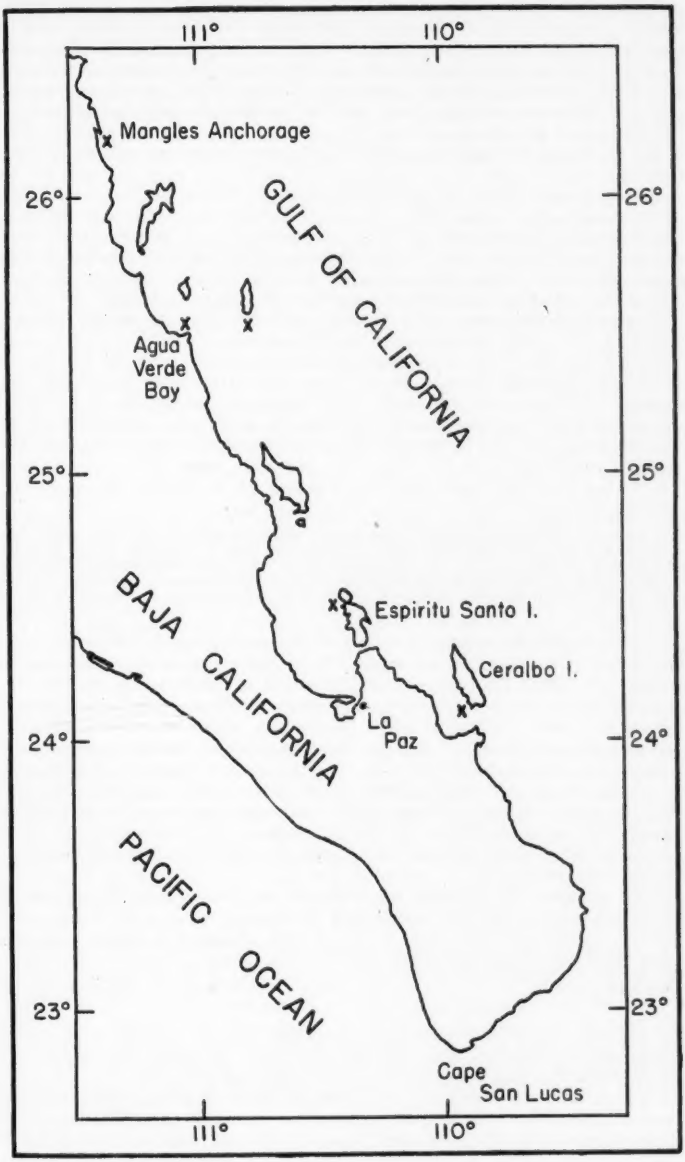

Fig. 1. The southern portion of Baja California, showing collection stations for Pacific mackerel within the Gulf of California.

NOTE ON THE GENERIC POSITION OF TWO BRAZILIAN SCIAENID FISHES, *ARCHOSCION PETRANUS* MIRANDA RIBEIRO, AND *SYMPHYSOGLYPHUS BAIRDII* (STEINDACHNER).[1]—Jordan and Eigenmann (1889, Annual Report Commissioner Fish and Fisheries for 1886: 343–415), in their revision of the Sciaenidae of America and Europe, divide the subfamily Otolithinae into two groups on the basis of the number of rays of the anal fin. In the first group, having from 15 to 21 rays, are placed the genera *Seriphus* and *Archoscion*. In the second, having from 7 to 13 rays, are placed the genera *Cynoscion* (=*Cestreus*), *Otolithus*, and *Macrodon* (= *Ancylodon*).

Miranda Ribeiro (1915, Archivos Museu Nacional Rio de Janeiro, 17: no pagination) described a new species which he called *Archoscion petranus*, but in so doing he disregarded the distinction made by Jordan and Eigenmann. *A. petranus* is said to have 9 soft anal rays while the genus *Archoscion* belongs in the division having the greater number. He evidently was impressed by the presence of canine teeth on the sides of the lower jaw, which is a character of the genus *Archoscion*. In his key to Otolithinae he follows Gill in recognizing both *Isopisthus* and *Archoscion* as separate genera but this division is not recognized by Jordan and Eigenmann.

The fish, of which I have examined two examples from the island of São Sebastião, State of São Paulo, keys out perfectly to *Cynoscion* in Jordan and Eigenmann's paper, and should be known as *Cynoscion petranus* (Miranda Ribeiro). However, difficulty has been experienced in attempting to place this fish in its proper *subfamily* according to the characters given by Jordan and Eigenmann, which are repeated by Jordan and Evermann, (1898, Bull. U. S. Nat. Hist. Museum 47(2): 1393–97).

In Jordan and Eigenmann's paper the following key is used for the subdivision of the family Sciaenidae:

a. Vertebrae typically 14+10, the number in the abdominal region always greater than that of the caudal; lower jaw prominent; teeth not villiform; edge of preopercle entire; second anal spine weak and adnate to the first ray; the first spine minute and often obsolete. Otolithinae, I
aa. Vertebrae typically 10+14, the number in the caudal region always greater than that in the abdominal; second anal spine usually well developed and usually joined to the first soft ray by a distinct membrane ..... Sciaeninae, II

I have examined the skeleton of several Otolithinae and found that there is a great difficulty in deciding if two of the vertebrae are caudal or abdominal. These vertebrae are found just behind the typical abdominal vertebrae. The first one of them has a haemal arch, but it also bears ribs. These are attached to the two small apophyses which are found just below the haemal arch. The vertebra which immediately follows this one presents the same situation. However, here the apophyses for the attachment of the ribs are very closely approximated. Also the ribs here come down as if they were a haemal spine, being very close together. From there on the vertebrae are typically caudal. Apparently the only other American author who has worked with Otolithinae and made vertebral counts is Ginsburg (1930, U. S. Bureau of Fisheries, Bull. 45: 71–85). But in his paper he gives only the total number and does not distinguish caudal and abdominal vertebrae.

In the specimens which I counted, including in the caudal region each vertebra that has a haemal arch, the following results were obtained:

Species	Abdominal	Caudal	Total
C. nebulosus (Cuvier and Valenciennes)	11	14	25
C. petranus (Miranda Ribeiro)	11	14	25
C. nobilis (Ayres)	11	14	25
C. reticulatus (Günther)	10	13	23

If we define as abdominal vertebrae the ones that bear ribs, then the results of these countings can be readily obtained from the table above by adding two to every item under abdominal and subtracting two from every item under caudal.

It is clear that in adopting any of the criteria above, these four species would not key out as Otolithinae where they are supposed to go. So, it appears to me that the principal character used by Jordan and Eigenmann in their analysis of the Sciaenidae is somewhat poor, and that search should be made for a better criterion.

Miranda Ribeiro (1915, Archivos Museu Nacional Rio de Janeiro, 17) separates

1 In the preparation of this note assistance was received from Prof. George S. Myers of Stanford University, to whom I am grateful.

Cynoscion bairdii (Steindachner) as a new genus, *Symphysoglyphus,* on account of the occurrence of canine teeth at the tip of the lower jaw.

I have examined two specimens of 24.5 cms. in standard length, from Santos and Cananeia, State of São Paulo, Brazil. In them the canine teeth are not very conspicuous, although one can distinguish them. In one of these specimens there are, in the exterior row of teeth, four canines in the most anterior part of the right mandible, and two on the left mandible in the corresponding region. Also there are on the left mandible two sockets, anterior to the canines referred to above, containing developing teeth. In both jaws this series of canines is continuous posteriorly in a series of small teeth which diminish in size as one proceeds backwards, although on the left mandible there is a gap in this series where probably one of the teeth fell out. On the second specimen about the same situation is found, but all the teeth are curved backwards, and the second closest canine to the symphysis in the left mandible is more conspicuous than in the other specimen. After this there is a socket followed by one canine and then the series of small teeth begins. In the right mandible five canines are to be found before the series of small teeth, there being a socket between the third and fourth canines. Moreover, Jordan and Eigenmann do not mention canines in their example from Pará. Steindachner's type was much smaller than my example, and it is possible that the canines are larger in the young than in adults. Under these conditions, Miranda Ribeiro's new genus does not appear to be very well founded, and the closeness of *C. bairdii* to the other species of *Cynoscion* makes the separation seem unnecessary. The species should be known as *Cynoscion bairdii* (Steindachner).—Francisco J. S. Lara, *Natural History Museum, Stanford University, California.*

RECORDS OF LANTERN FISH IN PUGET SOUND.—Lantern fishes of the family Myctophidae are usually found along the Pacific Coast of the United States, ranging from southern California to northwestern Alaska. Five species of this family, namely: *Diaphus rafinesquii* Cocco, *Electrona thompsoni* Chapman, *Lampanyctus leucopsarus* Eigenmann and Eigenmann, *Myctophum californiense* Eigenmann and Eigenmann, and *Tarletonbeania crenularis* Jordan and Gilbert, are known to occur in offshore Washington waters. The latter two species have been reported from the Puget Sound region by Kincaid (1919, Wash. State Dept. of Fish. and Game, Thirtieth and Thirty-first Ann. Repts. of State Fish Comm.: 119). Schultz and DeLacy (1936, J. Pan-Pac. Res. Inst., 11: 63), however, were unable to confirm the occurrence of *T. crenularis* within these waters.

An addition to the distribution records of this family was acquired during the course of routine stomach analyses of spring salmon (*Oncorhynchus tshawytscha* Walbaum) taken by sports fishermen at Point Defiance near Tacoma, Washington, some 160 miles inland from the Pacific Ocean. Seventeen lantern fish in various stages of digestion were recovered on February 11, 1948, from a 60.5 cm. salmon by Mr. Walter Kirkness of the Washington State Department of Fisheries. The largest specimen measured 45 mm. in standard length and was identified as the white-finned lantern fish, *Diaphus rafinesquii.* The remaining specimens, measuring from 10 to 25 mm., were badly mangled but were recognized to be small-finned lantern fish, *Lampanyctus leucopsarus.* Both species have not been previously recorded in Puget Sound.

Of further interest is the fact that Pritchard and Tester (1944, Bull. Fish. Res. Bd. Can., 65: 1-23), in the most recent of their extensive studies on the food of the spring salmon in British Columbia, were unable to determine if lantern fish contributed to their food supply. Lantern fish were found, however, in the stomachs of coho salmon (*Oncorhynchus kisutch*). The specimens recovered in the southern Puget Sound area indicate that, in these waters at least, lantern fish play a definite role in the economy of spring salmon.—Bell M. Shimada, *School of Fisheries, University of Washington, Seattle 5, Washington.*

REVIEWS AND COMMENTS

THE AMPHIBIANS AND REPTILES OF NEBRASKA. By George E. Hudson. Nebraska Conservation Bulletin No. 23, 4: 146 pp., pls. 1-30, maps 1-32, 1942.—The illustrated account of the amphibians and reptiles of Nebraska, by Dr. Hudson, is based on much active collecting; a single species of salamander, nine of frogs and toads, nine of lizards, twenty-eight of snakes, and nine of turtles are reported. These are described as to identification characters and coloration, with a full list of the known locality records in Nebraska, maps of distribution, and half-tone figures of all but one snake. The volume is supplied with glossary and bibliography. The "hypothetical list" is properly separated from the authentic one.

The work exhibits well the borders of the range of the species that reach the limits of their distribution in Nebraska, and these are useful to any more general account of the animal geography of North America.

The mapping of the species that are generally distributed illustrates the limitations of the form of spot maps used, since their scale is inadequate to exhibit ecological distribution, and the absence of records from intermediate counties can be interpreted only as the result of lack of collecting.

The zoological and zoogeographic objections to the employment of states as boundaries in faunal papers seem to be compensated by practical considerations. The present work is a competent example of a state-sponsored faunal report. It is clearly an indispensible aid to every interested amateur student of amphibians and reptiles in Nebraska or in the adjoining states. By summarizing the knowledge of distribution and of habits of the species in the Nebraska region, additions to this body of knowledge are facilitated for students who do not have access to a large library.

From my personal background of long years on the farm, I may testify that the most essential function of a handbook such as that of Dr. Hudson lies in its availability to farmers and their children, who are most directly in contact with the creatures described, and for whom an interest in the natural history of their own acres constitutes a priceless widening of mental horizons.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

VOICES OF THE NIGHT. Albert R. Brand Bird Song Foundation at Cornell University. Comstock Publishing Co., Ithaca. 1948. $6.50.—The four vinylite records (eight sides), of the voices of the common frogs and toads of the eastern and southern United States form a welcome addition to the teaching resources of the naturalist, whether his teaching be directed to a circle of children and friends or in the classroom. The album does much more than this—it places "on record" one of the most essential of taxonomic differences, and one that is in part quite independent of structural change. It is of fundamental theoretic importance that differentiation of species, with the establishment of distinctive characteristics (the "characters" of the taxonomist), and with the initiation of effective segregation of populations, should be possible by the development of psychological differences in voice and in mechanisms for its recognition. The whole sequence of morphological differentiation, for which an isolating mechanism is essential, may follow initial psychological changes of whatever origin.

The quality of reproduction in the individual frog voices appears to be uniformly excellent, without the distortion or emphasis of metallic sounds that appears in some of the bird voices previously recorded. It is evident that the mechanics of the recording process are greatly facilitated by the nature of the performer and the possibility of using the microphone directly and at the correct distance.

The background sounds convey an extraordinary impression that one is actually at a woodland pool or knee-deep in a swamp at night. It may be recommended to every herpetologist who becomes immersed in editorial or other paper work to renew his enthusiasm by turning off the lights and playing one of these records to himself in the dark.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

PROPOSED REPRINTING OF BOULENGER'S BRITISH MUSEUM HERPETOLOGICAL CATALOGUES.—In 1937 the British Museum (Natural History) reissued the eight volumes of Günther's "Catalogue of Fishes" (1859-1870) in a photographic facsimile, which, except for the slightly thinner paper, is an exact duplicate of the original work. Second-hand sets of this most important of all ichthyological treatises had been bringing up to $200, and availability of the reprint, at the low price of approximately $15 (at the present exchange rate), has been a great and continuing boon to ichthyologists.

Boulenger's British Museum catalogues of reptiles and batrachians occupy an even more important place in herpetology than Günther's Catalogue does in ichthyology, especially since they are beautifully illustrated. They also have long been out of print and now bring very high prices when upon rare occasions single copies are offered by second-hand dealers. Younger herpetologists and institutions needing these complete monographs of the living species of reptiles and amphibians of the world have frequently despaired of obtaining them at any price.

A recent suggestion by the undersigned that the British Museum issue facsimile editions of the Boulenger catalogues brought an interested response from Mr. H. W. Parker, Keeper of Zoology. He points out that concrete evidence that there would be no financial loss would have to be presented before the project could be considered, and suggests some sort of canvass of American herpetologists who might be interested in purchasing copies.

Cost has not been discussed, but prospective purchasers would naturally have to have some notion of the probable prices of the different volumes. The prices for the 1937 facsimile volumes of the fish catalogue are almost exactly the same as the original prices of the first edition. While it is to be hoped that a somewhat comparable price ratio could be maintained for the herpetological catalogues, it should be realized that printing costs in Britain have risen sharply since 1937. The original prices, at the present exchange rate, were as follows: *Batrachia Salientia* (1 vol.; 503 pp., 30 pls., $6.06), *Batrachia Gradientia* (1 vol.: 127 pp., 9 pls., $1.82), *Chelonians and Crocodiles* (1 vol.: 311 pp., 6 pls., $3.03), *Lizards* (vol. 1: 436 pp., 32 pls., $4.04; vol. 2: 497 pp., 24 pls., $4.04; vol. 3: 575 pp., 40 pls. $5.24), *Snakes* (vol. 1: 448 pp., 28 pls., $4.25; vol. 2: 382 pp., 20 pls., $3.55; vol. 3: 727 pp., 25 pls., $5.24). The total for all nine was $37.27, a price for which the *Batrachia Salientia* alone could not be obtained today.

Individuals and institutions interested in purchasing one or more of these nine volumes are urged to write immediately to the undersigned, *on one-cent postcards*, giving name, address, volumes in which interested, and number of copies of each—nothing more. These cards will *not* be considered to be orders for copies, but merely an expression of desire to buy if the volumes, or part of them, are reissued at a reasonable price. The cards will be forwarded to Mr. Parker for his information. It hardly need be pointed out that the response to this request may determine whether the Boulenger catalogues will ever again become generally available.—GEORGE S. MYERS, *Natural History Museum, Stanford, California.*

AMPHIBIANS AND REPTILES OF THE PACIFIC STATES. By Gayle Pickwell, Stanford University Press, 1947: xiv + 236, 64 pls., 20 textfigs. $4.00.—In the United States, at least, there is a need for good books to stimulate the interest of the layman in the natural history of his region. This need is especially evident in herpetology, and apparently this book is written in an attempt to fill that need in the Pacific States.

After a brief introduction, Pickwell devotes two chapters to the various species of amphibians and reptiles of the region, describing in a few sentences their distinctive characters and ranges. The "Life Habits" of the two classes are discussed under the topics of habitats, food and feeding habits, reproduction and growth, and enemies and defensive mechanisms. A chapter on collecting and care of the animals in the laboratory is followed by sixty-four plates, keys to all of the adult forms and to some amphibian larvae and eggs, a glossary, and a bibliography.

The brief notes describing the forms serve as supplements to the keys and plates in identification. The part of the book dealing with habitats, although stating that such and such a form occurs in the lowlands whereas another occurs in the mountains, does

not make an explicit point of the relationship between physiography and fauna, an ecological relationship that the layman or young student could carry over from one region to another and from one animal group to another. The remainder of topics in the "Life Habits" chapters receives only cursory treatment without any suggestions for interesting and original observations that may be made by the intelligent amateur student on the behavior of amphibians and reptiles.

Approximately 3/5 of the species are illustrated in the plates. These are not of consistent quality. Some are too poor to be of any assistance in identification; others, such as those of a garter snake swallowing a toad, are excellent. The bibliography, though extensive, consists of references for statements made in the text. There is no attempt to supply a bibliography that will direct the interested beginner to the proper references.

Generally speaking this book is a disappointment. The writing is poor. It is characterized by repetition of such awkward sentences as, "In the Far West there is only one genus in the family Salamandridae." Technical terms (parasphenoid, for example) are introduced into the book without any accompanying explanation or figure. The author also injects the question of name priority in the case of *Ambystoma tigrinum melanostictum*. This topic has no place in a book of this kind. Finally, Pickwell does a disservice to his intended audience by such remarks as: "In his study of amphibians and reptiles, one learns that the blood temperature of these vertebrates is variable; learns with pride that if he can say they are poikilothermal, he has mouthed a great word, has acquired a great knowledge . . . and when it is added that only birds and mammals . . . are homoiothermal, then the knowledge that is attendant upon science is happily advanced." A remark such as this leaves this reviewer with the feeling that perhaps the layman would do well to avoid reading this book.—ROBERT F. INGER, *University of Chicago, Chicago, Illinois.*

EDITORIAL NOTES AND NEWS

Western Division Meeting

THE 1948 meeting of the WESTERN DIVISION, AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS, was held on June 22-23 at Berkeley, California, as part of the annual meeting of the PACIFIC DIVISION of the AAAS. There were two half-day programs and two symposia, with an attendance of 32 to 58. The symposia, on "Aggregations of Reptiles and Amphibians" and "Racial Studies in Fishes," were held in conjunction with the WESTERN SOCIETY OF NATURALISTS. The herpetological sessions were held in conjunction with the HERPETOLOGISTS LEAGUE.

Two student awards were made: first in ichthyology to HARBANS LAL AURORA, for a paper on habits and early life history of *Porichthys notatus;* second in ichthyology to CLARK HUBBS, for a paper on speciation in the genus *Gibbonsia.* There were no awards in herpetology.

The following new officers were elected: *President,* J. R. SLATER, 3009 N. 11th St., Tacoma 6, Washington; *Vice-President,* J. L. HART, Pacific Biological Station, Nanaimo, B.C.; *Secretary-Treasurer,* ANITA E. DAUGHERTY, California State Fisheries Laboratory, Terminal Island Station, San Pedro, California.—ANITA DAUGHERTY, *Secretary.*

Instituto de la Salle

A RECENT letter to DR. E. R. DUNN from our esteemed Honorary Foreign Member, BROTHER NICÉFORO MARIA, brings the tragic news of the almost total destruction of the famed INSTITUTO DE LA SALLE, of Bogotá, during the Colombian riots of April 9-10, of this year. All of the buildings were sacked and fires started: only the chapel, a laboratory and the partially completed theater were saved from the flames. Only the herpetological collections are intact.

Brother Nicéforo writes: "My health is good and I am not at all discouraged! I want to rebuild our collections and our library, totally destroyed, and do hope to find help from our friends and well wishers of North America . . . We lost all our scientific books and papers, our cataloges, our many notes, our laboratories, even our personal things . . . I was preparing a monograph of the bats of Colombia (some 84 forms). My fine collections of bats—900 specimens, nearly all collected by me—my notes, photos, and drawings, were burnt. Besides reptiles and amphibians, you know that I study mammals, birds, fishes, crustaceans, aracnoids and fossils. I was proud of my specialized library; I must say that not a single description was saved from the fire of the so many things that I had collected in 40 years' work or had under my care."

Many North American museums are deeply indebted to Brother Nicéforo for his generous contributions of Colombian material to their collections. Their co-operation and that of his numerous friends and colleagues here is urgently needed in building up again a reference library on the fauna of Colombia and of the adjacent areas. Please check your libraries for pertinent duplicate reprints, and send them and copies of your own papers on the fauna of this area to BRO. NICÉFORO MARIA, *Instituto de la Salle, Bogotá, Colombia.*

Grace Olive Wiley

THE colorful career of GRACE OLIVE WILEY was ended on July 20, when she died less than two hours after she was bitten on the finger by a cobra. Mrs. Wiley, widely known for her love for and skillful handling of poisonous snakes, had been Curator in the Minneapolis Museum for twelve years, then joined the staff of the Brookfield Zoo. In 1937 she moved to Cypress, California, where she established a small snake zoo in her own home. Many of her trained snakes had appeared in motion pictures .

News Notes

LOREN P. WOODS, Associate Curator of Fishes, U. S. National Museum, left on June 26 for a three-weeks expedition to Bermuda for the Chicago Natural History Museum. Upon his return to the National Museum, he will continue until September 1 to work on the Bikini fish collections with DR. L. P. SCHULTZ, Curator of Fishes, after which date he will return to the Chicago Natural History Museum to assume again his permanent position as Curator of Fishes of that institution.

DR. EDWARD C. RANEY, of Cornell University, will spend three months, June to September, at the U. S. National Museum working on the Bikini Fishes with DR. SCHULTZ. The latter states that the descriptive catalogue of the Northern Marshall Island fishes has progressed somewhat beyond the halfway mark, that 34 families out of about 67 are completed.

DR. WILLIAM A. GOSLINE, for the past three years Assistant Curator of Fishes in the Museum of Zoology, University of Michigan, has resigned to accept a position as Associate Professor, Department of Zoology and Entomology, University of Hawaii, Honolulu 10, Territory of Hawaii. Dr. Gosline assumed his new duties on September 15.

DONALD S. ERDMAN, Division of Fishes, U. S. National Museum, is collecting fishes in the Persian Gulf in a co-operative expedition between the Arabian-American Oil Company and the Smithsonian Institution. He left on March 21 and will return in early September.

Recent changes of staff in the fisheries part of the U. S. Fish and Wildlife Service include the following: DR. LIONEL A. WALFORD has been promoted from Chief, Section of Marine Fisheries to Chief, Branch of Fishery Biology.

DR. C. M. MOTTLEY changed from the Fish and Wildlife Service as Chief of the Inland Fisheries Section to work in the Statistical Division of the Army Air Forces.

DR. GEORGE A. ROUNSEFELL has transferred from the Washington, D. C., office as Chief of the Anadramous Section to Chief, Atlantic Salmon Investigations at Orono, Maine.

MR. CLINTON ATKINSON has transferred from senior scientist of International Pacific Salmon Fisheries Commission at New Westminister, B. C., to Chief, Middle Atlantic Investigations at College Park, Maryland, for the Fish and Wildlife Service.

Release of Captive Turtles

YOUNG specimens of *Pseudemys f. floridana* (LeConte) and *P. scripta troostii* (Holbrook) are sold as pets by the thousands in the New York market and throughout eastern United States. When the purchasers tire of caring for them, they are frequently released in rural areas regardless of their natural range. This practice is heartily to be condemned, both because the chances of survival are meager and because it leads to herpetological confusion.

Together with many other northeastern zoos, the New York Zoological Park has been the recipient through the years of great numbers of pet turtles. Surplus northern species have been released within their range in localities where it was felt they would have more than an even chance to survive. The southern species, on the other hand, have been a constant source of concern. It seemed inadvisable to kill them, yet to maintain an increasing surplus was out of the question.

Last March, during a field trip to Jasper Co., South Carolina, we shipped live serpents to New York. On one of the return trips, the otherwise empty boxes arrived filled with southern terrapins.

When the boxes arrived, there were 2 Florida terrapins and 15 Cumberland terrapins. I had the choice of releasing them or destroying them. I chose the former course. The Florida terrapins were released on private territory well within their range, but the Cumberland terrapins—prevalent in the Gulf States—are not known to be native to South Carolina.

This is to notify all herpetologists that should a Cumberland terrapin be recovered in Jasper Co., South Carolina, it may be one of the specimens released by us or one of their offspring. It does not necessarily signify an extension of the natural range of this species.—BRAYTON EDDY, *New York Zoological Park, New York City.*

List of Fish Names

A LIST of common and scientific names of the better known fishes of the United States and Canada has been published by the AMERICAN FISHERIES SOCIETY, (Special Publication No. 1, Ann Arbor, Michigan, 1948, 45 pages). It is available to non-members of the Fisheries Society at 25 cents per copy from DR. W. C. BECKMAN, Society Librarian, Museums Annex, Ann Arbor, Michigan. This list represents the efforts of a committee of seven North American ichthyologists in selecting the most appropriate, single common names for species which are generally recognized by common name. The purpose is to promote a universal acceptance of single names for reasons of convenience. In the list, common names are grouped at the family or order level, and there are separate alphabetical lists of common and scientific names cross-indexed by number to the family grouping. The question of adopting this list of fish names as "official" for COPEIA manuscripts should perhaps be discussed at our next Society meeting.

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